SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 28, 1902.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE RÔLE OF CHEMISTRY IN UNIVERSITY EDUCATION.**

THE installation of a new chemical laboratory as an adjunct to university education, while not unusual in our country, is always attended with interesting features. From a description of the plans of this building, published in SCIENCE, in December, 1900, I learn that an attempt has been made to combine all the modern features of value which recent laboratories have developed. It is true that the material of which this edifice is composed is mostly the product of Kansas. In fact, the stone, in part, was taken from the very site on which the laboratory stands. The plans, however, which were adopted and the details which were carried out are the results of an extensive inquiry and personal inspection on the part of the director of the laboratory and the architect. I could not but notice, in looking over these detailed plans, how many of the best features of modern laboratories with which I have been acquainted have been incorporated into the plans of this building. We have here a complete structure designed for a specific purpose, built under the personal direction of those most skilled and competent, both in architecture and technical knowledge, and now

* Address delivered at the dedication of the new chemical laboratory of the University of Kansas, at Lawrence, October 16, 1902.

it has reached a finished state ready to be dedicated for the great purpose for which it was designed and constructed.

It seems to me that no feature of our modern university education is so strikingly set forth in the last few years as that one which seeks to adapt physical and material means to educational purposes. We are no longer satisfied with a mere enclosure of four walls which keep out the rain and water and which offer no other material advantages for study and research. I am not forgetful of the fact that some of the greatest accomplishments of the human intellect, in the way of search after truth and knowledge, have been secured under the most adverse circumstances. Berzelius, one of the greatest of chemists, pursued his simple researches in a laboratory established in a kitchen and with appliances which a third-grade high school would now reject as totally unfit for any useful purpose. We should not forget, however, that in the impartation of instruction, and in the conduct of research, we have passed the stage of first settlement and the opening of practically unknown ways. The ground which is to be covered is well mapped out. We know its physiography and geography and we are warned by conspicuous placards, which we see everywhere, that this particular field is preempted and already under culture. The courtesy which we owe each other leads us to respect the claims which those who have gone before us have made, and to seek for other fields of usefulness not yet marked out.

Thus the simple appliances and the vast open fields of a hundred years ago are now wanting, and we need the greatest refinement of every possible kind in order to make becoming progress. We hail, therefore, with delight every new foundation embodying new modern improvements devoted to the cause of science, and especially that particular science, which today we are permitted to speak of in detail, chemistry. It is, perhaps, no more fortunate than any of the others with which it is associated in increasing the sum of human knowledge. There are, however, some peculiar circumstances connected with the foundation of an institution for chemical instruction and research which differentiate that science from its sisters and which call for some special comment.

As a factor in the education of our youth, chemistry may be regarded from many distinct points of view. In the first place, the data which chemistry has established are elements of a liberal education. In modern times the whole tendency in chemical work is towards specialization. Unless a man knows some one thing more intimately than anybody else in the world, he has little prospect of becoming professionally useful and renowned. It is no longer a case of knowing one whole science better than any one else, because almost every science has grown beyond the understanding of any single individual, but it is a question of knowing some particular thing, some minute branch of the science, in a way in which no other one comprehends it.

Specialization in science, however, should never be allowed to interfere with the elementary education of the one who is to be devoted to special work. More and more as I study this problem, it seems to me that a man who in his future life is to become eminent as a specialist should, of all others, lay broad and deep the foundation of his training. Whatever function a man may perform in life, he should have a general knowledge of the languages, mathematics, literature and the sciences, and among them chemistry. I would not like to say *especially* of chemistry, because the members of each profession may be justly accused of magnifying their own science so

that its relative dimensions are very much distorted. But cutting myself loose as much as possible from the ties of my profession, it does seem to me that the fundamental data of chemistry are especially useful as elements in the foundations of a liberal training. In other words, the liberally educated man ought to know something of the composition of the earth on which he lives, of the minerals and precious stones which it yields, of the water which covers its surface, permeates its atmosphere and gathers in clouds above his head; of the plants which grow upon the soil and the elements which compose them; of the food which comes upon his table and the principles of nutrition; of the number of elementary substances known and some of their general properties; of the principles of physical chemistry which unite chemistry with physics; of some of the technical operations in which the science of chemistry is a controlling factor, such as the manufacture of starch and sugar, of steel and iron, of leather and fertilizers, of dye-stuffs and textile fabrics, and many other similar processes. Why, may I ask, should we expect a liberally educated man to be acquainted with all the heathen mythologies and to be on speaking terms with all the mythical gods and goddesses who inhabit Olympus or Walhalla, and to be absolutely ignorant of the composition of the air he breathes and the water he drinks?

No one can accuse me of belittling the claims of classical and historical education in molding character and developing intellect. All of my life I have been a strong advocate of the old system of classical instruction. I have seen with regret the battlements of classical learning broken down under the heavy fire of scientific assailants, and through the embrasures thus made I have seen the heights taken by storm and in many instances destroyed. But while I fully realize the immense value of all such studies in general education, I cannot be brought to the belief that a liberally educated man should be practically ignorant of the physical and biological sciences.

It is not necessary in order to have this general knowledge that he should be a specialist in any sense of the word. Our scientific and popular magazines teem with articles written by specialists which bring within easy access of the intelligent reader all the data of which I have spoken. He can know the principles of astronomy without being a Newcomb; he can know the fundamental data of chemistry without being a Gibbs; he can comprehend the conditions of existence and the evolution of organic life without being a Darwin; he can grasp the practical points of botany without being a Gray. It seems to me, therefore, that one of the great functions of chemistry in university education is to teach to the liberally educated youth the principal data of chemical science, even if it does not attempt to make him a professional chemist.

I think it may, therefore, be taken for granted that what is known as a liberal education should consist in part of a knowledge of the data of chemistry to which allusion has been made.

It perhaps might be pertinent to this subject to discuss the period of higher education which should be devoted to the study of chemistry, and to determine the position in the course of physical studies which chemistry should have. Such a discussion, however, would lead to endless differences of opinion and would probably result only in adding one additional opinion to the many already in vogue. That there is a natural sequence in the study of physical sciences will probably be admitted, but that that sequence is always invariable is a matter of some doubt. The final purpose in view will doubtless have

much influence upon the legitimate sequence of studies. If chemistry, therefore, be studied only as a contribution to a liberal education, it seems to me to make little difference in what part of the higher curriculum it comes. If, on the other hand, the student is to become a specialist in any other science, especially physical science, the position of chemistry in the course of study becomes more important. And if, finally, a student is to become a specialist in chemistry the position of this science in his course of study becomes most important.

We find in a study of chemical phenomena that there are certain natural forces which are highly efficient in effecting chemical changes. These are light, heat and electricity, all of which by modern theories are regarded as special forms of vibration in the elementary particles of matter or ether. Since an artisan should be acquainted with the character of the tools he uses, and since light, heat and electricity become important tools in chemical processes, it would seem natural that at least that part of physics relating to these forces should precede purely chemical studies. There are, however, very few purely chemical problems that require the higher mathematics, and thus it happens that the student of chemistry who has a working acquaintance with arithmetic, algebra and a superficial knowledge in geometry and trigonometry, is able to perform most of the mathematical operations which the study of chemistry requires.

Further than this, chemistry may be regarded as a college study only and not in the light of the university proper. Our American universities, almost without exception, are built around the college as the central school, meaning by the college that part of the course of instruction which is destined to give the foundation of a liberal training without specialization. Wherever specialization enters into a college, the college to that extent becomes a university of higher learning; in other words, a kind of a graduate school before graduation.

I have often thought that it might be well to confine the college to the old-fashioned type, especially since it is only an integral part of the university, and to reserve specialization until after the degree of A.B. has been secured.

Thus, for the purpose of this address, it is not necessary to dwell upon the particular year or part of the curriculum when chemical studies should enter. I have, however, very grave doubts of the wisdom of teaching extensive courses of practical chemistry in the high schools. It is not expected that any one should obtain a professional knowledge of chemistry in a high school, and yet working laboratories have been established in most of our high schools entirely similar to those used for training professionals. It may be an erroneous opinion, but I have always held to the view that in childhood and youth we find the proper periods of life for learning languages. Now a knowledge of one's own language, especially if one be an English-speaking person, is quite impossible without a study of the sources whence it has sprung. Therefore, an English scholar must first of all have a working knowledge of the classical languages, so-called, that is Latin and Greek, and also a practical knowledge of German, at least, which is one of the languages evolved from the Anglo-Saxon, or rather the Saxon part of the Anglo-Saxon. While it is convenient to know other ancient languages and all modern languages, it must be confessed that the period of childhood and youth is not long enough to become practically acquainted with more than three or four languages, besides the vernacular. Hence, while not neglecting nature lessons and the teaching of the explanation of the ordinary

phenomena with which we are surrounded, it seems to me wiser to devote the period of infancy and childhood and early youth largely to learning English, Greek, Latin and German. The youth who, at sixteen, finds himself ready for college with a practical knowledge of the four languages I have mentioned, has laid one of the cornerstones of a liberal education. There is no other period at which languages can be so easily acquired as that period in which nature teaches languages herself, and a year of Latin at nine or ten is worth two years at twenty or thirty.

I would like, therefore, to see the science training of our high schools confined to the explanation of common phenomena, and not include any expensive, time-consuming and exclusive laboratory practices. This may all seem heresy, coming from a scientific man, but I believe it is good gospel, nevertheless. I have often been mortified at the English composition of college and even university graduates. Men who have attained eminence in particular branches of study often seem incapable of expressing their thoughts in any proper way. Their English is inexact, clumsy and inconsequent. Clear expression seems to me to be the legitimate outcome of clear thinking, and the neglect of those early studies which enable one to express himself clearly and forcibly is a fault which can only be remedied by long years of mortification and hard labor.

Chemistry, in the second place, plays an important rôle as a help in the study of other sciences. Since it enters as an element into so many other sciences, except that part of physics already mentioned, it seems to me that for scientific purposes, or, in other words, for instruction in scientific specialties, chemistry should be practically the first science studied. I would point out only a few instances in which chemistry becomes an important adjunct in other branches of scientific investigation. In geology it teaches the composition of rocks, and this often throws important light upon their origin. The presence of quantities of phosphoric acid in a rock shows that it must have been derived, or probably was derived, from organic life. If iodin and bromin be found in mineral deposits, it is an indication that they were of marine organic origin. The geologist, of course, must know whether his rocks are composed of silicates, carbonates or sand, for these three classes of chemical compounds make up the great bulk of the rock deposits of the earth's crust. To be sure, it does not require a great deal of chemistry to determine this, but it does require chemical knowledge, and thus a knowledge of chemistry must be one of the elements in the education of a geologist.

In the case of mineralogy, the importance of chemistry as a preliminary study is more pronounced. Morphology is, of course, an important aid to the mineralogist in determining species, but the final test is always composition. The mineralogist, therefore, must be not only a chemist, but a chemist of skill and experience, or else he is ignorant of an important part of his profession.

In metallurgy we find chemistry again playing a most important rôle. While the working of metals, from an artistic point of view, is entirely independent of a knowledge of their composition, the production of metals from their ores is a chemical process pure and simple. The metallurgist is first of all a producer of metals, but when he works them into given forms he becomes an artist. Chemistry, in the guise of metallurgy, was the foundation of the first of the arts, for it is evident that if man had never emerged from the Stone Age he never could have progressed

in knowledge and civilization to the present point. It was the discovery of the science of metallurgy which enabled the human race to span that great chasm between the age of stone and the age of steel.

In a science apparently utterly removed from chemistry, viz., astronomy, chemistry plays no unimportant part, for it is through the aid of physical chemistry only that the composition of the sun and the stars has been revealed to man.

In the biological sciences chemistry plays no less an important rôle. It is the fundamental basis of animal and vegetable physiology. The processes of growth in the animal and vegetable are purely chemical. It is true that modern chemistry has not reached the skill of nature, and we are unable to reproduce in the laboratory all the changes which matter undergoes in the animal and vegetable organism, but those we are not able to reproduce are none the less purely chemical and show the high order of talent which nature has provided in her chemical processes, talent which it is well we should emulate, although we may never be able to imitate.

"The weapons in the armory of the modern physiologist are multitudinous in number and complex in construction, and enable him in the experimental investigation of his subject to accurately measure and record the workings of the different parts of the machinery he has to study. But preeminent among these instruments stand the test-tube and the chemical operation typified by that simple piece of glass.

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"If even a superficial survey of modern physiological literature is taken, one is at once struck with the great preponderance of papers and books which have a chemical bearing. In this the physiological journals of to-day contrast very markedly with those of thirty, twenty or even ten years ago. The sister science of chemical pathology is making similar rapid strides."*

I shall not speak in this address of the purely chemical industries, because they have so often been described. There the rôle of chemistry is paramount. It is no longer an aid, but a master.

Thus in this rapid review is seen the importance of chemistry in other sciences, and, therefore, its place in the university curriculum must always be a capital one. This necessity has been recognized from the very first in the higher education in this country. In the old-fashioned colleges in which our fathers received a training which made them, perhaps, more eminent than their sons have become, before the days of the renaissance of science, if we may regard it as ever having been vigorous in the past, chemistry was always the first of the sciences provided for. When the laboratory gradually became evolved as a means of instruction, it was always the chemical laboratory which was first established in all our higher institutions, and when the day of specialization permitted more than one professor to teach the sciences, it was usually the professor of chemistry who was first segregated from the scientific chaos. And for this reason to-day in every institution of higher learning, whatever the specialty may be which the student of science studies, chemistry becomes an integral and fundamental part of his course of instruction. While in schools of chemistry it may not be necessary for the student to study mining, civil and electrical engineering, in schools of mining, civil and electrical engineering the student is always required to study chemistry.

Chemistry is also the fundamental sci-

* Extract from presidential address delivered by W. D. Halliburton to the Physiological Section at the Belfast meeting of the British Association for the Advancement of Science.

ence in the training of the pharmacist and the physician. Take out of the pharmacopœia and the materia medica the contributions which chemistry has made, and you have little left but empiricism.

The remedial principles of plants are separated, purified and studied by chemical means. Synthetic chemistry has added to materia medica hundreds of valuable remedies. Standards of purity for drugs are fixed by chemical processes.

Thus we see the importance of chemistry in the rôle of training, not only as a means of a liberal education, but also as an adjunct to other scientific professions.

Let us now consider for a short time chemistry in the rôle of the higher university instruction or in the graduate schools. We now emerge from the region where chemistry is studied for education and for help, to a region where it is studied as a profession. There is no other science to my mind, and I think I will be able to prove it to you statistically and otherwise, which holds the place in the higher universities and graduate schools which chemistry occupies. Fortunately, I have been spared the labor of collation in this matter, by an interesting article which appeared in SCIENCE for September 5, 1902, entitled 'Doctorates Conferred by American Universities.' The doctorate referred to is doctor of philosophy, and in most instances it was conferred in the graduate school of the university mentioned; if not it was conferred only as the result of a special training in the university itself. Twenty-seven universities, representing the principal institutions in the United States of the university class, enter into the statistical data referred to. The period of observation extended over five years, from 1898 to 1902 inclusive. During this period, 1,158 degrees of doctor of philosophy were conferred by the universities mentioned. Of this number 568 were conferred for purely scientific studies, as distinguished from those other studies in universities which, I think, are known as the humanities. It was always a mystery to me why such studies as chemistry, physics, geology and botany, which lie so near all the necessities of life, should be excluded from that class which has received such a high-sounding name. I think there is more humanity in a science which produces edible roots than in one which studies those of Greek and Latin origin, and more philanthropy in the arts which produce fuel and clothing than in those which bring forth syntax and prosody. But we will not stop to quarrel with appellations, and if the sciences are not humanities in name they are certainly so in fact.

Thus, of the total number of degrees of doctor of philosophy conferred in five years, 49.5 per cent. were given in the sciences; in round numbers, half of the whole number.

An interesting table is also given of the percentage of the degrees conferred in the various sciences. We find that of the 568 degrees of doctor of philosophy conferred in the sciences, 137 were granted for the study of pure chemistry, 18 for physiological chemistry and physiology, and 3 for mineralogical chemistry and mineralogy. The total number of chemical degrees, therefore, was 158, which is 27.8 per cent. of the total number of degrees given in the sciences. Compare this number of 158 with the degrees given in the other leading sciences, viz., 68 in physics, 65 in zoology, 63 in psychology, 61 in mathematics, 53 in botany and 32 in geology. No other science had as many as 20 degrees, and three had only one each.

Thus we see the enormous preponderance of chemistry in the higher scientific education. It has more than double the number of degrees of any other science. It must be remembered also that chemistry is a

most expensive and most difficult science to teach. While other sciences require extensive collections of material, these collections remain available for all subsequent classes. On the other hand, chemistry requires the most extensive and expensive of all scientific laboratories, and the materials and fixtures of these laboratories are subject to the severest strain and the greatest wear and tear. For this reason, in many universities, not only are the students required to pay the ordinary fees, but also special laboratory fees to cover the wear and tear of the materials which they use. But in spite of this increased expense, we see in this country, and doubtless it is true in other countries, that chemistry leads all the sciences in the number of students of higher learning and secures the lion's share of the degrees of doctor of philosophy. In this respect chemistry must be regarded, in the light of statistics which are indubitable, as the most important of all the sciences in the rôle of the university instruction.

It may be thought by some that the hard and cold facts of a science like chemistry have a tendency to repress the imagination and arrest the development of those faculties of the mind which create poetry, romance and oratory. There may be some foundation in fact to such a suggestion. The legitimate functions of the imagination are doubtless to supply the data which knowledge and experience do not give. From this point of view it is evident that, as knowledge advances, the field reserved to imagination grows smaller. There is little room in the domain of science for the rhythm of poetry or the creatures of fancy. Yet it must be admitted that many of the exact sciences do afford opulent opportunities for the exercise of a trained imagination. Indeed, so apparent is this fact that John Tyndall, one of our great scientists, has written a treatise on the scientific use of the imagination.

It is as difficult to grow eloquent over atomic weights and percentage composition as over statistics and finance. Oratory deals with the possible and perhaps probable, the ornament rather than the reality. Thus it comes that the great poets, the great orators, the great painters, and, to some extent, the great writers, are found in the early history of a people or a language. Advancing knowledge clips the wings of poesy and pricks the rotund phrases of the orator.

Nevertheless, even in so prosaic a science as chemistry the imagination has played no unimportant part. It was the genius of a Dalton that first imagined the atomic theory. Newlands and Mendeleeff pointed out the existence of undiscovered elements, and with an imagination as scientific as it was brilliant assigned those missing elements their proper places, and, in a measure, described their properties. A Rayleigh and a Ramsey saw in the realm of nature the probability of a series of elements of negative properties, and argon, krypton, neon and xenon have been isolated. The creation of the infinitely attenuated ether with its vibrant properties is purely a result of imagination. Though it may be erroneous in conception, it certainly has been helpful in classifying the phenomena of light, heat and electricity. So, too, the structural formula of molecules, assigning to atoms and groups of atoms a definite position in the molecular edifice, has been highly helpful in explaining chemical relations and physical properties.

These are only some of the instances which show that, even as a training for the fancy and imagination, chemistry holds no insignificant position.

From the point of utility the rôle of chemistry in education has no mean place.

Unless an educated man can perform some service for humanity better than he could have done without training, then to this extent education is useless. It has been said education often spoils a boy. Quite true. Food often kills. Water carries germs of disease and death and destroys thousands. Yet food and water are necessities. Because education often proves powerful for evil is no reason for opposing it. What crimes have been committed in the name of liberty! What sins in the name of religion! It is too late in the progress of the world to declare against the higher education for this reason, either in its purpose or in its results.

George Sand fifty years ago discussed this supposed tendency of science to harden the heart and blunt the sensibilities. Following is a colloquy between Jean Valreg and the author:

Jean Valreg.—"It [society] seeks in science applied to industry the 'kingdom of the earth' and it is *en train* to acquire it. Do you believe then that all these great efforts to know, of invention and activity by which the present age shows its riches and manifests its power will render it happier and stronger? As for myself I doubt it. I do not find the true civilization in the improvement of machines and in the discovery of processes. The day when I learn that every cottage has become a palace, I shall pity the human race if that palace covers only hearts of stone."

George Sand.—"You are both right and wrong. If you take the palace filled with vices and excesses as the aim of human labor, I am of your opinion, but if you regard the common welfare as the necessary way to reach intellectual health, and the development of the great moral virtues, you would not curse this fever of material progress which tends to deliver man from the ancient servitude of ignorance and misery."*

Among the useful sciences none compares with chemistry in nearness to human needs and in ability to supply them. We have already seen what an important adjunct it is in the study of other sciences. Equally potent is it in its relations to the useful arts. Many standards may be used in measuring the progress of a nation and its relative position in respect of other countries. Some would gauge its progress by its churches; some by its schools; some by the liberties of the people; and some by the reverence paid its women. I have often said, to descend to more material things, that the most reliable rule with which to measure the progress of a people is the quantity of sugar and soap it consumes. Sugar and soap are only illustrations of what the chemical arts have done for man.

There is scarcely an art into which chemistry does not enter. Iron and steel are chemical products; so are paper, pens and inks. Textile fabrics and their dyes owe almost everything to chemical science. In nearly all the manufacturing arts chemistry is the chief factor. In the agricultural arts it is the dominant science. In Kansas chemistry has developed the deposits of coal, of oil and gas, of gypsum and building stones, of materials for the manufacture of cement. Here in this university has been made a careful study of your mineral waters which cannot fail to bring material profit to your people. The wonderful fertility of your fields has heretofore shown little need of chemical study, but you should not lose sight of the fact that the continued prosperity and advancement of agriculture must depend largely on chemical investigations. The conservation and increase of plant food, looking to an increasing yield of crops, must condition

* 'La Daniella,' Vol. I., pp. 13–14.

any lasting agricultural prosperity. The demands on agriculture increase with each passing year, and science will show the way to make surely productive those areas which are now of little value because of deficient rainfall. Water is the chemical reagent which is most potent in crop production. The chemist and the physicist, with the help of the engineer, will show the way to its most economical utilization. Chemistry will supply the mineral foods which the plant needs. In the early history of a new country we uniformly notice the rapid decrease in the fertility of the virgin soil. This is due to a system of farming little better than robbery. Its basic principle is to take from the soil everything possible and give nothing in return. Necessity finally puts an end to such practices and education provides the means for the inauguration of scientific agriculture. Then the exhausted fertility of the soil begins to return. The fields become more productive and each step in advance is retained and becomes the base for further progress. We may confidently predict that the future years will see abundant food for the increasing millions of population. Life will have less of labor and more of leisure for study and recreation. In all the arts which will help in the amelioration of the conditions of existence, chemistry will enter as an important part.

The state builds well, therefore, in an endowment of the kind we celebrate to-day. As in astronomy we study the infinitely great, so in chemistry we investigate the infinitely small. We seek the very nature and origin of matter and thus come near to those first combinations of simple cells which condition the vital spark.

In the early history of the race we find men dedicating fountains, groves and temples to the worship of mythical deities. To-day we set apart churches, schools, libraries and laboratories for the public good.

More than a liberal training, more than professional ability and technical skill, are those attributes of the man, which make him a source of help to the family, the community, the municipality and the state. Providence in the family, morality in the community, public spirit in the municipality and patriotism in the state are the real purposes of all training. To these ends the educated man must be a bread-winner, of upright conduct, ready to give his services to the city and his life to the republic. He must know how to produce wealth. He must be acquainted with the needs of the community. He must understand the service he is to render to the municipality and have that enlightened patriotism which, while not separating him from a political party, acts first of all for the good of the whole people. The future years will find the leaders of the people among the graduates of the universities, because if the universities are not remiss in their duties, their graduates will be better fitted for leadership. There is no talisman in a diploma. Only ability will count. We recognize the important contributions which all branches of learning will make to this equipment of the successful man of the coming years. In dedicating this building to chemical science it has seemed only meet to point out some of the ways in which our science may aid in the work.

H. W. Wiley.

U. S. Department of Agriculture.

THE HUXLEY LECTURE ON RECENT STUDIES OF IMMUNITY WITH SPECIAL REFERENCE TO THEIR BEARING ON PATHOLOGY.

II.

The methods hitherto employed for the study of bacterial poisons have not gener-

ally been calculated to reveal the presence of toxins with the characters indicated, even if such existed in the cultures. Recently, however, a beginning has been made in this direction, and we have already become acquainted with certain toxins of an interesting nature, to which I desire to direct your attention.

Intrinsically and in their general bearing upon the subject before us, the recent investigations of Flexner and Noguchi upon the constitution of the toxins in snake venom are of special importance. It was in snake venom that Weir Mitchell and Reichert first demonstrated the existence of that class of poisons often called, although with doubtful propriety, toxic albumins. Investigations of snake toxins are of peculiar interest for many reasons, not the least of which is their resemblance to bacterial toxins. The demonstration by Sewall of the possibility of active immunization from venom, and the further studies by Calmette and by Fraser of this phenomenon, and especially of the protective and curative properties of antivenin are well known.

Until recently it has been generally held that the venom toxins resemble in molecular structure the diphtheria and the tetanus toxins in being single bodies with a combining or haptophore group and a toxophore group of atoms. The researches of Flexner and Noguchi, now in progress, of which only the first part has been published,* necessitate a quite different conception of the nature and manner of action of venom toxins from that previously entertained. I have followed with great interest the work of Professor Flexner on toxins, begun several years ago in my laboratory when he was my assistant and associate, and since continued along new lines in his laboratory at the University of Pennsylvania, and I wish to acknowledge his generosity in permitting me to use in this lecture certain unpublished results of his and Noguchi's investigations.

* Flexner and Noguchi, 'Snake Venom in Relation to Hæmolysis, Bacteriolysis and Toxicity,' *Journal of Experimental Medicine*, March 17, 1902, Vol. VI., p. 277.

These investigations have shown that the toxic action of venom upon red blood corpuscles, leucocytes, nerve cells and other cells is like that of the duplex cytotoxins already described—that is, it depends upon the combination of intermediary bodies contained in the venom, on the one hand with the animal cells for which these bodies respectively have affinities, and on the other hand with corresponding complements contained, not in the venom, but in the cells or fluids of the animal acted on. For example, it is well known that the addition of venoms to fresh blood brings about the quick destruction and solution of the red corpuscles. If, however, certain venoms be added to red corpuscles which have been thoroughly washed with isotonic salt solution so as to remove all the complement, the corpuscles are agglutinated but not dissolved, although it can be shown that substances from the venom (intermediary bodies) have entered into combination with the corpuscles. If now a little fresh serum which contains the complement, and by itself may be an excellent preservative of normal corpuscles, be added to these venomized corpuscles, they are promptly dissolved.

Preston Kyes, working in Professor Ehrlich's laboratory, in an investigation just published* on the mode of action of cobra venom, confirms the conclusion of Flexner and Noguchi concerning the amboceptor nature of cobra venom, and adds

* Preston Kyes, 'Ueber die Wirkungsweise des Cobragiftes,' *Berl. klin. Woch.*, 1902, Nos. 38 and 39. I am greatly indebted to my friend Professor Ehrlich and to my former pupil Dr. Kyes for putting me in possession of the main results of these interesting experiments before the date of their publication.

much that is new and important to our knowledge of this subject. He finds that the washed blood corpuscles of certain animals are directly dissolved by cobra venom, while those of other animal species require the subsequent addition of complements or adjuvants to bring them under the influence of the venom. But even in the former case a complementary body is essential to the reaction, this, however, being not a serum complement, but an endocomplement contained within the red corpuscles. Of great significance is the demonstration by Kyes of still a third substance, namely lecithin, which is capable through combination with the venom intermediary body of completing the hæmolytic potency of venom.* The discovery for the first time of a definite, crystallizable substance with the power of uniting, like a complement, with an intermediary body, and thus completing the formation of a cytotoxin, is evidently of fundamental importance. The suggestion by Ehrlich and Kyes that possibly the cholin group is the toxophore group of lecithin is particularly interesting in the light of F. W. Mott's valuable studies of chemical processes concerned in degenerations of the nervous system.

The researches of Flexner and Noguchi and of Kyes, therefore, have taught us that in poisoning by venom the bodies of human beings and of animals contain in the form of complements, or alexins† as they are also called, the substances which are most directly concerned in the act of poisoning. The venom serves merely to bring into the necessary relation with constituents of the body cells poisons we already harbor or may generate, but which are harmless without the intervention of intermediary bodies. These poisons within us are powerful weapons, which when seized by hostile hands may be turned with deadly effect against our own cells, but which are also our main defence against parasitic invaders. We see here as everywhere that nature is neither kind nor cruel, but simply obedient to law.

Flexner and Noguchi have demonstrated experimentally that, like the hæmolytic, so also the leukotoxic, the neurotoxic, and other cytotoxic properties of venom depend upon combinations of venom intermediary bodies with complements contained in the cells poisoned by venom or in the fluids bathing these cells. Particularly striking are their experiments showing *in vitro* and under the microscope the cytolytic action of cobra venom upon certain large molluscan nerve cells in the fresh state. The complement essential to this reaction is contained within the nerve cells. In previous experiments of Flexner and Noguchi there had been indications that a special class of intracellular complements are concerned in some of the toxic effects of venom upon cells. The positive demonstration by Preston Kyes of a special class of intercellular complements or endocomplements is unquestionably of great pathological interest, and seems destined to play an important part in the explanation of many morbid conditions in connection both with endogenic and with exogenic intoxications, probably also in such phenomena as self-digestion or autolysis.

Snake venom is a rich mine of diverse toxins, and, on account of its pathological importance, I must mention one of the cytotoxins discovered there by Flexner and

* The objections made by Calmette (*Compt. Rend. Acad. des Sc.*, 1902, T. CXXXIV., No. 24) to Flexner and Noguchi's interpretation of their experiments as to the amboceptor nature of venom have been completely overthrown by the experiments of Preston Kyes.

† There is some objection to the use o the term 'alexin' as a synonym for 'complement' as the former was applied originally by Buchner to substances which we now know to be combinations of complements with intermediary bodies.

Noguchi, as it may be that a similar toxin is produced by certain bacteria, and under still other conditions. As is well known, one of the most striking lesions resulting from poisoning by certain venoms is the occurrence of abundant hæmorrhages in various tissues of the body. This effect has been generally attributed to the direct action of venom on the red corpuscles and on the coagulability of the blood, but the experiments of Flexner and Noguchi indicate that these hæmorrhages are due to the presence in venom of a cytotoxin which has the power of dissolving endothelial cells—in other words, an endotheliolysin. Dr. Flexner suggests the name 'hæmorrhagin' for this special toxin which causes extravasations of blood through its direct solvent action upon capillary endothelium, an effect which is readily demonstrated under the microscope. It is hardly necessary for me to stop to emphasize the clinical and pathological importance of the discovery of an endotheliotoxin, a kind of poison which may prove to be of special significance in the interesting group of hæmorrhagic infections, and perhaps also in purpura and kindred affections.

The foregoing newly-discovered facts, which I have sketched only in bare outline, illustrate in a striking way the fruitfulness of methods and conceptions which we owe to recent studies of immunity. The results of these investigations, however, are significant beyond the mere facts disclosed, important as these are. They have for the first time revealed in normal toxic secretions, readily introduced under conditions of nature into the tissues of man and animals, cellular poisons akin to the complex hæmolysins, neurotoxins, and other cytotoxins of immune and some normal serums, which have aroused so much interest and experimental study during the past four years. The most noticeable difference between the venom cytotoxins and those hitherto observed in immune serum is the far greater resistance to heat of the intermediary bodies of the former; but we are already acquainted with considerable variations in the sensitiveness to heat both of different intermediary bodies and of complements. That snake venom should contain only one half of the complete poison, the other and the really destructive half being widely distributed in the blood and cells of man and of animals, is an instance of a curious kind of adaptation, of interest from evolutionary, as well as from other points of view.

In consideration of the often emphasized analogies between venom toxins and bacterial toxins, these facts render it highly desirable to make a systematic search of bacterial cultures by proper methods and under suitable conditions for complex cytotoxins. At present substances of this nature are not known to exist in our cultures. There have been discovered, however, within the past three or four years certain bacterial toxins which have a curious resemblance in some of their properties to the complex antibodies of blood, although, so far as they have been carefully studied, they appear to have the simpler constitution of the soluble toxins, like those of diphtheria and of tetanus. I refer to the bacterial hæmolysins, leucolysins, hæmagglutinins, precipitins and coagulins. There is no reason to suppose that this list exhausts the number of those actually present, for it is evident that it includes chiefly bodies readily demonstrable in test-tube experiments. It would be surprising if cytotoxins which act specifically upon red and white corpuscles were the only ones of this class produced by bacteria; in fact, we have every reason from pathological observations to believe the contrary.

It has become evident that more refined methods than mere observation of the coarse effects of injecting into animals

the filtrates or the killed bacteria of our cultures are required for the detection of the subtler and more specific cellular poisons. Instances are rapidly increasing in which by improved methods cultures of bacterial species once believed to be practically devoid of toxicity are found after all not to be so poor in toxins, even of the soluble variety. One of the earliest and most instructive illustrations of this is the discovery by Van De Velde of a leucocyte-destroying poison, named leucocidin, in exudates caused by infection with *Staphylococcus aureus,* and also in filtrates of staphylococcus cultures, which had been previously regarded as almost entirely free of toxic power.

More widely distributed in cultures of different species of bacteria are the hæmolysins, of which the first example, discovered in 1898 by Ehrlich in cultures of the tetanus bacillus, was carefully studied by Madsen the following year, and which have since been investigated by Kraus with Clairmont and with Ludwig, Bulloch and Hunter, Neisser and Wechsberg, Todd, Besredka and others. The list of bacterial species known to produce in cultures substances of this nature capable of dissolving red blood corpuscles is already a long one, and includes the bacilli of tetanus, of green pus, of typhoid fever, of acute dysentery, of diphtheria, of plague, the pyogenic staphylococci and streptococci, the pneumococcus, and many other bacteria. Nuttall and I noted in our first descriptions of *Bacillus aerogenes capsulatus* over ten years ago its capacity of laking blood, so that I was not surprised to find recently that a hæmolysin can be demonstrated in cultures of this organism. The blood-destroying property appears to stand in no definite relation to virulence, nor is it limited to pathogenic bacteria. It pertains also to many putrefactive bacteria. The strongest bacterial hæmolysin hitherto observed was found by Todd in cultures of *Bacillus megatherium,* which is a widely distributed saprophyte.

As already stated, none of these bodies has been shown to belong to the class of complex hæmolysins in blood, which have been far more exhaustively investigated than any other of the specific antibodies. Doubtless there is at present among bacteriologists too great a tendency to attribute to the less carefully studied antibodies characters which have been worked out in detail only for the hæmolysins of immune serum. It would lead too far to attempt here a discussion of the special characters of the various bacterial hæmolysins, which present in different specimens curious and at present unexplained divergences as regards resistance to heat and several other properties. It must suffice to indicate briefly what is known of the pathological importance of this interesting group of bacterial toxins.

In view of the abundant clinical and pathological evidence of extensive destruction of red corpuscles in the course of many infectious diseases, it is certainly significant to find that many bacteria are endowed with a specific hæmolytic power. The question is how far we are justified in applying to the actual conditions of infection the existing experimental data upon this subject. Assuredly here, as everywhere, results of test-tube experiments, helpful in suggestion as they may be, should not be utilized without further evidence to explain morbid phenomena within the infected human or animal body. While much more work upon this subject is needed before our information will be exact or complete, the observations and experiments of Besredka,* Kraus and Ludwig,† and

* Besredka, *Annales de l' Institut Pasteur,* 1901, XV., p. 880.

† Kraus and Ludwig, *Wien. klin. Woch.,* 1902, p. 382.

others have already demonstrated that bacteria may exert their blood-destroying power within the living body. This hæmolytic capacity of microorganisms affords an explanation, although certainly not the only one, of the secondary anæmias which are such a marked feature of many infectious diseases, as streptococcic and other septicæmias, pneumonia, typhoid fever, scarlatina, and others. The hæmoglobinuria which is a recognized although rare complication of various infectious diseases may be referable to intoxication with unusually powerful bacterial hæmolysins, or to an exceptional lack of resistance of red corpuscles.

Hæmoglobin, however, is not necessarily present in solution in the blood plasma, for the destruction of the damaged red corpuscles may take place within the large phagocytes of the spleen and the hæmolymph glands, as is well known to occur on an extensive scale in typhoid fever and some other infections. A familiar example of the action of bacterial hæmolysins is the post-mortem reddening of the inner lining of the heart and blood vessels, an effect which may be due to putrefactive bacteria or may appear very soon after death, especially from septicæmia caused by *Streptococcus pyogenes*, which, as has been shown, may lake the blood during life.

The fact that certain common saprophytic bacteria may produce energetic hæmolysins, as pointed out by Kraus and Clairmont and by Todd, has a possible bearing upon the etiology of certain obscure anæmias not of infectious origin, particularly upon the interesting observations and the theory of William Hunter concerning their causation by absorption of toxins from the alimentary tract. Todd found cultures of *Bacillus megatherium* so strongly hæmolytic that the intravenous injection of 1 c.c. of the filtrate into guinea-pigs was followed by hæmoglobinuria, 10 c.c. being fatal. Human red corpuscles are sensitive to this hæmolysin.

Normal human and other blood serums contain in varying amounts antihæmolysins, which protect the red corpuscles from the action of some of the bacterial hæmolytic agents. Specific antihæmolysins are readily produced by immunizing injections of bacterial hæmolysins, and are generated also in the course of infections. Lang suggests that the augmentation of the osmotic resistance of the erythrocytes which has been noted in some infectious diseases, as well as in icterus and some other morbid conditions, may be a reactive phenomenon caused by the presence of hæmolytic toxins.

Intimately associated with the hæmolysins in cultures are the bacterial hæmagglutinins,* substances which have the power to clump red blood corpuscles. Among unicellular organisms both the capacity to produce agglutinins and the aptitude for agglutination seem to be very widely distributed. The bacterial hæmagglutinins, in analogy with the bacterial hæmolysins, are apparently of simpler constitution than the serum agglutinins, being destroyed at 58° C., whereas the latter are not injured by temperatures under 70° C. In order to demonstrate in cultures the hæmagglutinins it is generally necessary to eliminate in some way the action of the associated hæmolysins, which can be done by using small quantities of the culture fluid or by keeping the mixture of fluid and red corpuscles at zero temperature.

I know of no observation directly demonstrative of the action of bacterial hæmagglutinins within the living body in infections, but this subject is of such recent knowledge that it has been as yet scarcely investigated. Certainly there are morbid conditions which seem highly indicative of

* Kraus and Ludwig, *Wien. klin. Woch.*, 1902, p. 120.

the operation of substances agglutinative of red corpuscles. Probably every one with large experience in the examination of fresh blood in disease has noticed that sometimes red corpuscles, examined immediately after withdrawal of the blood, have a peculiar tendency to form clumps which cannot readily be broken up. This phenomenon, which is certainly suggestive of the action of an agglutinating agent, I have observed especially in some cases of septic infections and of cirrhosis of the liver.

Furthermore, I would emphasize the support given by the recognition of hæmagglutinins to views advocated many years ago by Hueter and by Klebs concerning the occurrence of thrombi composed of coalesced red blood corpuscles. Such thrombi I believe to be not uncommon in typhoid fever and other infections, especially in small blood vessels. I have elsewhere called attention to the evidence in favor of the interpretation of many of the hyaline thrombi as derived from agglutinated red corpuscles.

It can scarcely be doubted that substances agglutinative of white blood corpuscles are also produced by certain bacteria, and that these are concerned in the clumping of pus cells and of leucocytes within the living body, but it would not be profitable to discuss this matter without more exact information than we now possess.

In this connection I may say that not only the discovery of the bacterial hæmagglutinins, but also that of the hæmolysins and the leucolysins, is likely to shed new light upon certain aspects of the difficult subject of thrombosis. The red corpuscles undergo various morphological changes under the influence of different bacterial hæmolysins acting with varying intensity. Distortions of shape, throwing out of projections, and detachment of colorless particles resembling platelets, can sometimes be seen. These observations are of special interest with reference to the doctrine, already strongly supported, that platelet thrombi originate from disintegrated red corpuscles. Levaditi, and Neisser and Wechsberg, have described, as the result of intravenous injections of *Staphylococcus aureus*, areas of coagulative necrosis in the rabbit's kidney, which they attribute to thrombi composed of disintegrated leucocytes caused by the staphylococcus leucocidin, to which I have already referred.

I have dwelt at some length, although of necessity incompletely, upon the bacterial hæmolysins, leucocidins and hæmagglutinins, because we are better informed about these agents than concerning other members of this recently recognized class of bacterial toxins. I have already expressed the opinion that similar poisons acting specifically upon other cells of the body are produced by bacteria; indeed neurotoxins and nephrotoxins of this type have been reported. The difficulties in the way of direct proof of the existence of these other bacterial cytotoxins are greater than in the case of those acting upon the red and the white blood corpuscles, but doubtless they can be overcome. Of course we have evidence of the action of bacterial poisons upon various body cells, but this is not enough. At present we can apply only in a vague and unsatisfactory way to the explanation of pathological processes most of the knowledge of this kind which we possess. What is urgently needed is a separation of these poisons and a determination of their source, constitution, mode of action and degree of specificity along such lines as have been followed so fruitfully in the investigation of the soluble diphtheria and tetanus toxins, those other toxins of bacteria and of venom already considered, and the cytotoxins of normal and of immune serum. The path leading apparently

in the right direction has already been opened, and, if I mistake not, its further pursuit is most promising of valuable results in the near future.

Consider by way of illustration how helpless we now are in our efforts to explain the characteristic lesions of typhoid fever on the basis of our knowledge of the properties of the typhoid bacillus. That these lesions are referable to the action of toxins cannot, I think, be seriously questioned. Especially from the investigations of Mallory, we know that the most characteristic histological changes of this disease consist in the proliferation of the reticular or so-called endothelial cells of the lymphatic tissue of the intestine and the mesenteric glands and of similar cells in the splenic pulp, and in the assumption by these proliferated cells of remarkable phagocytic activities towards the lymphocytes in the former situations and towards the red corpuscles in the spleen. Mallory believes that these changes are best interpreted by supposing that the typhoid toxin directly stimulates to proliferation the endothelial cells, which then devour their offspring, the lymphocytes, and the red corpuscles.

I have suggested as another explanation that the typhoid bacillus produces a lymphocytotoxin and a hæmolysin, and that the proliferation of the fixed cells is partly compensatory and partly for the increased production of macrophages. We already know that this bacillus generates a hæmolytic agent, and we also know that one of the effects of injection of hæmolysins is to increase greatly the number of macrophages containing red corpuscles in the spleen.

Through the kindness of Professor Flexner I have had the opportunity of studying the extraordinary changes produced in all the lymphatic glands and in the bone marrow of rabbits by injections of lymphotoxic or myelotoxic serum obtained by treating a goose with lymphatic or marrow tissue of the rabbit. One of the most striking effects of this poison for lymphocytes and other leucocytes is the very extensive proliferation of the reticulum cells in the lymphatic nodes and of the marrow cells. In the light of these observations it is clear that a positive demonstration of the production of a lymphotoxin by the typhoid bacillus would materially advance our understanding of the morbid anatomy of typhoid fever. Another lesion of this disease, only second in importance to those mentioned, is the occurrence of plugging of the small vessels. Dr. Fisher, in my laboratory, has recently shown that such thromboses are produced by the experimental inoculation of rabbits with the typhoid bacillus. I have already pointed out that many of these plugs are agglutinative thrombi.

Of course infectious diseases other than typhoid fever could also be cited, did time permit, as equally forcible illustrations of the aid which pathology may reasonably expect from more precise knowledge of the bacterial cellular poisons. It is probable that such knowledge will lead to improvements in the quality for therapeutical purposes of the so-called bacteriolytic serums, some of which, as now prepared, are not so wholly devoid of antitoxic properties as is often represented. We may also anticipate from investigations of the character indicated much light upon one of the most puzzling of bacteriological problems—the localization of bacteria in disease. Toxic lesions and the plugging of small blood vessels are certainly often of decisive influence in determining this localization, as has been demonstrated especially for the staphylococcus pyæmias by Muscatello and Ottaviano.*

* Muscatello and Ottaviano, *Virchow's Archiv*, 1901, CLXVI., p. 212.

The toxins to which I have chiefly directed your attention in this lecture are those produced by bacteria. But, as already pointed out, we now know that the animal body has the power to produce specific poisons directed not only against invading bacterial cells, but also against all sorts of foreign cells. Following the discovery by Belfanti and Carbone in 1898 of this capacity in relation to injections of blood a wholly new domain of biology has been opened to experimental research. Attention has been withdrawn for the moment to a considerable extent from the bacterial toxins and concentrated upon the animal cytotoxins. Here new facts and conceptions of absorbing interest have been disclosed in an abundance and with a rapidity which are simply bewildering.

It was my original design to include in this lecture a consideration in some detail of these animal cytotoxins, but so much time has been occupied with other aspects of the subject that I am compelled to abandon this intention. This is perhaps less to be regretted, inasmuch as I understand the main purpose of these lectures to be the presentation of applications to medicine and surgery of scientific discovery, and it is precisely this side of the recent work on animal cytotoxins which seems to me in the main not yet ripe for profitable discussion on this occasion. It is true that facts of much scientific and practical interest have been discovered by the investigations, initiated by Shattock and by Grünbaum, followed by Landsteiner, Ascoli, Eisenberg, Kraus and Ludwig and others concerning the isoagglutinative and isolytic properties of human serums in health and in disease.

But the really great practical questions in this domain relate to the production of autocytotoxins in the human and the animal body. What is the nature of that very efficient regulatory mechanism underlying the horror autotoxicus (Ehrlich) which prevents either the action or the formation of autocytotoxins in consequence of absorption of our own degenerated and dead cells? Can this protective mechanism be overthrown by pathological states and self-generated cellular poisons become operative in the causation of anæmias, hæmoglobinurias, chronic interstitial inflammations, uræmia, eclampsia, epilepsy and other diseases? To these and similar important questions the existing experimental data seem to me too insufficient and inconclusive to furnish any decisive answer at present. I share, however, the hope and belief of many that here is a field for exploration which, although surrounded with many difficulties, gives promise of discoveries of a far-reaching and important nature. I anticipate that some future Huxley lecturer will find in this realm a fascinating theme.

In this connection may be mentioned the great pathological interest pertaining to the recent investigations of Jacoby, Conradi and others on the phenomena of self-digestion or autolysis of inflammatory exudates and necrotic material within the living body. One can readily convince himself of the energetic action of autolytic ferments by the simple experiment of placing a piece of fresh pneumonic lung in the stage of gray hepatization under chloroform and noting the rapid solution of the exudate, in contrast with the absence of this process in earlier stages of the disease. Conradi finds that bactericidal substances, to which he attaches much importance, are produced in tissues and cellular exudates undergoing autolysis.

Although my theme relates especially to the bearing of studies of immunity on pathology, it is hardly necessary to say that these studies were primarily undertaken to elucidate the great problems of predisposition and resistance to disease,

and that in this field they have borne their richest fruits. It is especially gratifying to note the close convergence of the two doctrines of immunity, the cellular and the humoral, brought about by these recent discoveries. On the one hand the phagocytic school, represented so brilliantly by Metchnikoff and his coworkers in the Pasteur Institute, recognize and apply to the fullest extent in the explanation of acquired immunity the cytolytic principles based upon the cooperative action of intermediary bodies and complements. On the other hand the humoral school, led by our German *confrères,* which has been so fruitful in results of the greatest scientific and practical value, recognize the cells, and especially the leucocytes and other cells of the blood-forming organs, as the immediate source of the protective substances. There are many differences in details, especially in terminology and in interpretation, which make the divergence seem greater than it really is. The essential difference between the two schools concerns the place where the two forces, intermediary body and complement, unite. All are agreed that the intermediary body exists free in the blood plasma, but Metchnikoff strenuously insists, especially on the basis of Gengou's experiments, that the complement or cytase is within the leucocytes, from which it is not secreted but can be liberated only through damage to these cells. This question certainly needs further investigation before it can be regarded as settled.

The deeper insight which we have recently gained into the nature of the forces concerned in immunity makes especially desirable the systematic study of the blood and other fluids of human beings in health and in disease with reference to their content of specific antibodies, particularly of the bactericidal substances. It can scarcely be doubted that knowledge of this kind will be in various ways of practical value to the physician and surgeon. The simplest procedure, and the one hitherto generally adopted, is the estimation of the bactericidal power of the blood serum *in toto.* For this purpose Professor Wright* has devised an ingenious method which in his hands has furnished extremely interesting information concerning variations in the bactericidal power of the blood as regards the typhoid bacillus in health, under the influence of fatigue, in the course of typhoid fever and after antityphoid inoculations. The older methods, however, while not without value, do not inform us of the total content of the blood in immunizing substances, and have led to very discordant results, particularly as to the influence of infection upon the bactericidal power. Thus Conradi† finds, in opposition to most previous experimenters as well as to the later results of Wilde, that infection with the anthrax bacillus does not at any stage influence materially the bactericidal properties of the blood.

A useful and readily applicable method for the determination separately of the intermediary bodies and of the complements of human serum is urgently needed. When one takes into consideration the plurality of complements and of intermediary bodies, the fallacies of interpretation which may arise from failure to take account of anticomplements, of anti-immune bodies, of complementoids, of amboceptoids, of deviation (*Ablenkung*) of complements, and other principles in this complicated subject, it is clear that the problem is not an easy one.

Notwithstanding these difficulties, work has already begun along these new lines, and has led to interesting results. We

* A. E. Wright, *Lancet,* 1898, I., p. 95; 1900, II., p. 1556; 1901, I., pp. 609 and 1532, and 1901, II., p. 715.

† Conradi, *Zeitschrift für Hygiene,* 1900, XXXIV., p. 185; 1901, XXXVIII., p. 411.

know that the content of the blood in specific antibodies, and especially in complements, varies in significant ways under diverse conditions, as in infancy and in adult life, in health, in different states of nutrition, under the influence of fatigue, of inanition, of pain, of interference with respiration, of alcohol, and in disease. The infant comes into the world with protective antibodies in the blood smaller in amount and less energetic than those possessed by the healthy adult. It is an important function of the mother to transfer to the suckling through her milk immunizing bodies, and the infant's stomach has the capacity, which is afterwards lost, of absorbing these substances in an active state. The relative richness of the suckling's blood in protective antibodies, as contrasted with the artificially-fed infant, explains the greater freedom of the former from infectious diseases.

The important question of the influence of preexistent disease in predisposing to infection has been brought nearer to a solution by recent studies of immunity. Schütze and Scheller* have demonstrated that, while the normal rabbit promptly regenerates the complements used up in consequence of the injection of hæmolytic serum, a rabbit infected with the hog cholera bacillus has lost this capacity. My former pupil, Dr. Longcope, has kindly placed at my disposal the unpublished results of an investigation which he is making under Professor Flexner's direction at the Pennsylvania Hospital of the intermediary bodies and the complements in human blood in different diseases. Colon and typhoid bacilli are used as the tests, as, unless one accepts Bordet's doctrine of the unity of complements, it is more important for the study of problems of infection to determine bacteriolytic rather than hæmolytic antibodies. One of the earliest results of the systematic bacteriological examinations which we make at all necropsies at the Johns Hopkins Hospital was the recognition of the great frequency of terminal infections, formerly often undetected by the clinician, in chronic diseases, particularly of the heart, the blood vessels, and the kidneys. Dr. Longcope finds, although not regularly, still in many cases of these diseases a marked reduction in the quantity of complements, which may amount to a total loss of the colon complements. The analysis of the cases brings out unmistakably a definite relation between this loss of complement and the predisposition to infection.

* Schütze and Scheller, *Zeitschrift für Hygiene*, 1901, XXXVI., pp. 270 and 459.

The study of a series of acute infections, chiefly of a surgical nature, shows that in the course of the infection complements are being constantly used up and regenerated, and that at any given time there may be an excess or a reduction of the bacteriolytic power of the blood. Thus far it has been found impossible in these acute infections to attach any prognostic significance to the amount of complement or of bacteriolytic power, nor could any definite relation be determined between the leucocyte count and the content of complements.

Although we have traversed, gentlemen, in this lecture a path which I fear has seemed to you a long and winding one, I am conscious that I have been able to point out the features of the prospect only imperfectly and incompletely. The extent and the richness in details have been embarrassing. I trust, however, that I have been able to indicate in some measure the great interest and importance to biology, to physiology, to pathology, to every department of medical science and art of investigations which have led to a deeper insight into certain manifestations of cellular life. What has been conquered by

these investigations is simply a bit of new territory pertaining to the intimate life of the cells, and we find here, as whenever we are able to penetrate deeper into this life, that there comes a flood of new light into every department of biology. The researches on immunity, which to some of short vision once seemed to threaten the foundations of cellular pathology, have served only to strengthen them. These researches, which have already led to the saving of thousands of human lives, and will lead to the saving of untold thousands more, have been carried on by the experimental method, and can be conducted in no other way. This method is as essential for the advancement of medical science as for that of any of the natural or physical sciences. To restrict unnecessarily and unjustifiably its use is nothing short of a crime against humanity. It is an evidence of the robust vitality of English physiology and medicine that in spite of unwarrantable obstacles thrown in their path their contributions to science in recent years have been so numerous and so important. The influence of English thought and action is great with us in America. See to it, my colleagues and men of science in the British Isles, that you retain for yourselves and hand down to your successors, at least without further impairment, the means of promoting medical knowledge and thus of benefiting mankind.

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SCIENTIFIC BOOKS.

International Catalogue of Scientific Literature; first annual issue—M, Botany. Published for the International Council by the Royal Society of London. London, Harrison & Sons, 45 St. Martin's Lane. Vol. I., Part I. May, 1902.

For some years the Royal Society has had under consideration the preparation of a complete index of current scientific literature, which now has materialized to the extent of a thick pamphlet of 378 pages, designated as 'part I., of volume I.' The part before us is devoted to botany, and from it we may make an estimate of the probable value of the complete work. The preface discusses the magnitude of the undertaking, and the inadequacy of a mere authors' catalogue, scientific workers needing subject indexes as well. This task being far greater than the Royal Society alone could undertake, international cooperation was sought, resulting in a conference of delegates in London, July, 1896. At this conference 'it was unanimously resolved that it was desirable to compile and publish, by means of an international organization, a complete catalogue of scientific literature, arranged according both to subject matter and to authors' names, in which regard should be had, in the first instance, to the requirements of scientific investigators, so that these might find out, with a minimum of trouble, what had been published on any particular subject of inquiry.'

Subsequent conferences were held in 1898 and 1900, the result being the appointment of an international council, the establishment of a central bureau in London, and the undertaking of the Royal Society to act as the publishers of the catalogue on behalf of the council. Provision is made for an international convention, which is to have supreme control over the catalogue, and which is to meet in 1905, and again in 1910, and every tenth year afterwards. It is to 'reconsider, and if necessary, to revise the regulations for carrying out the work of the catalogue.'

Seventeen branches of science are to be included in the whole catalogue, and these are arranged under the letters of the alphabet as follows: A, mathematics; B, mechanics; C, physics; D, chemistry; E, astronomy; F, meteorology; G, mineralogy; H, geology; J, geography; K, paleontology; L, general biology; M, botany; N, zoology; O, human anatomy; P, physical anthropology; Q, physiology; R, bacteriology. In this scheme physiology is made to include experimental psychology, pharmacology and experimental pathology. "Each complete annual issue of the catalogue

will thus consist of seventeen volumes." It is further stated that the price is to be £18 for the set, with varying prices for individual volumes, from ten to thirty-five shillings.

An examination of the present volume shows that the scheme of classification differs materially from that followed commonly in this country. Numbers of four figures, from 0000 to 9999, are assigned to subdivisions of the subject as follows: 0000 to 0999, general (including philosophy, history, biography, periodicals, etc., general treatises, addresses, pedagogy, institutions, nomenclature); 1000 to 1999, external morphology and organogeny (including teratology); 2000 to 2999, anatomy, development and cytology; 3000 to 3999, physiology; 4000 to 4399, pathology; 4400 to 4999, evolution; 5000 to 7999, taxonomy; 8000 to 8999, geographic distribution; 9000 to 9999, plankton. Ecology (spelled 'oecology') appears as an item under physiology, coordinate with growth, irritability, symbiosis, parasitism, etc. Paleobotanical papers are to be distributed under their appropriate heads and marked with a dagger (†). The pages devoted to the scheme of classification are printed in English, French, German and Italian. Following these is a topographical classification, for use in geography, geology, botany, zoology, etc., and which is apparently as satisfactory as any which might be adopted, although open to some criticism in details.

The authors' catalogue covers eighty-four pages, and includes 1,922 entries. This is followed by the subject catalogue, in which the arrangement outlined above is followed. This part of the book requires 240 pages, and apparently includes many titles not entered in the first list. As these are all papers published in the year 1901, and as we are promised a second part of the botany volume 'in the course of a few months,' it will be seen that the need of such a work as this is imperative.

In some quarters there appears to be a disposition to find fault with this catalogue on account of alleged sins of omission and commission, and also in regard to its plan of classification and some of its details. While there may be truth in these criticisms, it should be borne in mind that, in part, they come from those who are not experts in bibliography, and who are, therefore, not fully conversant with the difficulties of a complete classification. It will be well for us to remember that it is much easier to find faults in any proposed system than to suggest one which will not contain as many objectionable features. No doubt this catalogue will be of great value to scientific workers. Let us be thankful for it; let us buy it; let us use it; and let us trust that year by year it may grow better. Even if not quite what many of us desire, it is a very good piece of work —better, no doubt, than we ourselves could have made it.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

Catalogue of the Crosby Brown Collection of Musical Instruments of All Nations. I. Europe. New York, The Metropolitan Museum of Art. 1902. 8vo. Pp. xxxv + 302; pl. 53.

Some months ago (SCIENCE, June 13, 1902) attention was directed to the first part of a catalogue of the 2,800 musical instruments in the New York Museum. The catalogue of the European instruments, apparently about a thousand in number, has just been published and proves to be a remarkably fine piece of work. In the preparation of it Mrs. Brown has had the assistance of Mr. A. J. Hipkins and Rev. F. W. Galpin, both of England, whose previously published works show that no more competent authorities in England or America could have been called in. The former was associated in several investigations with the late A. J. Ellis, the translator of Helmholtz, and has written much on the history of the piano, etc.; and both have cooperated in the historical exhibitions that have taken place in England. For this catalogue Mr. Hipkins wrote a special introduction to the keyboard instruments, while Mr. Galpin identified many of the instruments, made the classification, wrote the prefaces to its several parts and added many notes.

The classification impresses the reader as simple and practical: it begins with 'Class

One, Stringed Instruments,' I. without a keyboard; II. with a keyboard; and under each (A) plucked, (B) struck, (C) bowed strings; III. with automatic mechanism. 'Class Two, Wind Instruments,' without and with a keyboard and with automatic mechanism, each divided into whistles and reeds. The instruments of these classes fill four fifths of the book. The come 'Vibrating Membranes,' 'Sonorous Substances' and 'Musical Accessories.' A long list of portraits of musicians follows, and the volume is closed by two full indexes, one by classes, the other alphabetical.

A striking feature of the catalogue is its copious illustration. Over fifty half-tone plates furnish a wealth of illustration unparalleled in musical literature except in a very few sumptuous books covering narrow fields. Of these plates twenty-four show each one family of instruments, from the smallest to the largest, as guitars, viols, recorders, clarinets, saxophones, saxhorns, etc.; generally these plates of families include also a measuring rod divided into inches and centimeters, by which the actual sizes of the instruments may be scaled off. The reduced copy of a chart in the Germanic Museum at Nuremberg shows, in a remarkably interesting way, the forms of the string and percussive instruments in use in successive centuries from the eleventh to the seventeenth; while the plate of the striking 'Egyptian Type Case' shows that the ancestors of most of our modern instruments were known on the banks of the Nile long before the date of the Pythagorean legend.

To secure examples of all these complete families, some of which are exceedingly rare, many reproductions have been obtained from European museums, as acknowledgments accompanying more than forty items make evident. And since the special aim of the collection is educational, many details of instruments are shown by dissections or models.

The descriptions of the several instruments vary in length from a couple of lines for some items up to three pages for the Cristofori piano, averaging, for the principal kinds of instruments, about a quarter of a page. The data are arranged in a systematic way, the parts of the instrument being taken up in a uniform order, and then follow the details of place, date and size, with occasional notes.

To keep the voluminous matter within the bounds of a 'handbook,' obviously pretty rigorous limitations must be observed; so only the most important historical and acoustical facts are added to the description, and these are put in very condensed form. For chatty historical matter one must still go to Engel, and for technical details to Mahillon. The region and period covered by this book, unlike those of the former catalogue, which dealt with Oriental instruments, make unnecessary any discussion of questions of the scale; for the diatonic or chromatic scale was here the universally accepted norm, and the few instances of enharmonic scales and similar deviations are of small importance.

These statements show more clearly than any mere words of praise could do what an admirable piece of work this book is: the fullness of the collection, the clearness of the classification, the care and system in description, the discriminating notes, the sense of expert knowledge, the freedom from trivial confusing details, the references to allied instruments from other countries, the cross-referencing and full indexing, the liberal illustration and the good typography, all conspire to make it almost as useful away from the museum as in the presence of the instruments. It should prove a valuable supplement to any dictionary of music, to any discussion of instruments from either the physical or the musical side, to such books as Lavignac's 'Music and Musicians,' and to any of the histories of music in use by clubs and students.

A book capable of such wide usefulness ought not to remain a local guide-book; the fact that it is not copyrighted may be an additional indication of liberality on the part of the donor and editor, but also suggests the doubt whether proper means are being taken, as by advertising or listing in the *Publishers' Weekly* or otherwise, to let librarians and students know of its existence.

CHARLES K. WEAD.

WASHINGTON, D. C.

Annual Report of the Chief of the Bureau of Steam Engineering of the Navy Department, 1902. Washington, D. C., Gov't Print. 1902. 1 vol. 8vo. Pp. 192; many plates, illustrations and tables of data.

Rear-Admiral Melville, over whose signature this report appears, as for a number of years past, presents to the Secretary of the Navy a statement of the progress of his department of the navy during the preceding official year which, as usual, gives an admirable exposition of the extent to which scientific method and scientific processes and the apparatus of applied science find place in that now complicated and implicated machine, the modern war-vessel.

The inspection and test of materials for the machinery of the navy have come to be so large and important a division of this work that two laboratories, one at Bethlehem, the other at Pittsburg, are occupied constantly in the chemical and physical analysis and tests required by the bureau. The young officers of the navy are given systematic training in this work. Sixty millions of pounds of steel were inspected and tested last year for use in construction.

A large laboratory for engineering is called for, a plan already endorsed favorably by the Department and by the naval committees of Congress. Such an organization has been established by the German Admiralty at Charlottenburg, and it has been found an important auxiliary, both as an aid in work in progress and as affording facilities for important researches in the applied sciences auxiliary to the work of the naval establishment. Experience shows that only systematic and scientifically expert work in investigation can be relied upon to insure the government against serious errors and large wastes and in maintenance of the navy in a maximum state of efficiency. 'The time has come when the Naval Academy should be primarily an engineering school,' and particularly as post-graduate work is coming to be more and more important. The Director of the Laboratory is expected to be one of the members of the old Naval Engineer Corps, several of whom have had large experience, both as practitioners and as members of faculties in technological institutions and in universities sustaining professional engineering schools. Investigations are already imperative regarding utilization of liquid fuels, the availability of the steam-turbine, the form and size of propellers, the special adaptations of electric energy and of electric machinery to naval purposes, the use of the storage battery, the corrosion of boiler- and condenser-tubes, the best forms of water-tube boilers, the use of systems of transmission of energy by use of compressed air, the balancing of marine engines, the adaptation of the gas-engine to marine work, and a multitude of minor matters.

A post-graduate course of instruction at the Naval Academy is urged as an advance of steadily and rapidly increasing importance, mainly in scientific and professional engineering departments. The naval 'War College' and the army schools of artillery and of other branches of the service are examples of already organized courses of this nature. The extension of the system is as important for the navy as has proved to be its long-established operation in civil professional schools for the industries of the nation.

A considerable amount of experimental investigation has been carried on by the Bureau during the past official year, and, in the study of the problem of adaptation of the water-tube boiler to naval purposes and of that of employing oil as fuel, especially interesting and fruitful work has been done. The water-tube boiler is evidently needed as a construction peculiarly well fitted for war-vessels, because of its comparatively small volume and weight for a given power, its safety under the high steam-pressures now coming into use and its fitness for use under emergency conditions of naval conflicts. Several forms are now employed and others are being tested as to safety, durability and reliability, with a view to the enlargement of the limitations now hampering choice. The use of fuel-oils is found to be entirely practicable and economical for general purpose, but there still remains a question whether the structural dif-

ficulties in the application of the system to the war-vessel may not be fatal to employment there.

Incidentally, a fact in sociology and economics comes into view. It was found impracticable to carry on work of research with men employed under the conditions obtaining in civil life and enlisted men were necessarily put on the work. Only men who would obey orders, work when required by the exigencies of the service and faithfully attend to duty, as in army and navy, could be relied upon. The trade-union rules were found to be fatal to efficiency, and the inference seems to have been plain that, in the industrial army as in the public service, effectiveness is not promoted where the rank and file take command.

The workings of the 'personnel bill' are commented upon with the conclusion that Mr. Roosevelt's bill is correct in plan and in principle, but that it has not been executed with either zeal or faithfulness, and that the efficiency of a navy dependent upon technical knowledge and practical experience, conjoined with high scientific attainments, is being seriously jeopardized by this disloyalty to law and to the service. Junior officers, it is stated, are not given either the scientific training or the professional training as mechanical engineers which are essential to the efficient operation of the 'engineer's war-engine,' as the writer has called the modern armored vessel, with its interior crowded with steam-engines and other machinery and electrical apparatus. Without extensive practical experience and a sound scientific education high efficiency cannot be hoped for, and the safety of the nation is too serious a matter to be subject to such risks as are sure to follow lack of zeal or of training in the management of so tremendous an engine of war as the armor-clad or cruiser. An 'emphatic general order' and rigid enforcement is demanded as essential, and immediately.

National ascendency on the seas and permanent safety against foreign aggression can only be insured by a sufficient and an efficient personnel as well as an amply powerful fleet. The navy of the United States, like that of Great Britain, needs men more than ships, to-day, and every proper means should be resorted to to make the service attractive and to secure competent officers, particularly in its departments of applied science.

Admiral Melville retires presently and this is his last official report. It is wise, frank and emphatic in its discussions of the requirements of a 'new navy' in the twentieth century. The influence of this testimony should be powerful and effective. The Chief of Bureau goes out of office leaving behind him a magnificent record of accomplishment, not only in the building up of the navy, but in achievements which, in variety as in importance, have probably never been rivaled.

R. H. Thurston.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, October.—'Solubility, Electrolytic Conductivity and Chemical Action in Liquid Hydrocyanic Acid,' by Louis Kahlenberg and Herman Schlundt. This is a continuation of the researches of the authors on solutions with other solvents than water. Lists of substances soluble and insoluble in liquid hydrocyanic acid are given. In the case of some solutes the electrical conductivity is greater than in water, while in other cases, notably with the acids, it is less. 'The Expansion of a Gas into a Vacuum and the Kinetic Theory of Gases,' by Peter Fireman. An abstract of this paper has already appeared in this journal (Science, N. S., XVI., 285). 'On the Displacement of Equilibrium,' by Paul Saurel. 'On the Critical State of a One-Component System,' by Paul Saurel.

SOCIETIES AND ACADEMIES.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

At the 557th meeting of the Society, held on November 8, Mr. C. G. Abbot, of the Astrophysical Observatory, described 'a device to obtain time signals of any desired interval from a clock work of uniform motion.' A chronograph with the attachment was exhibited. Signals at equal intervals of from one half second up to ninety seconds could be obtained. An adjustment was provided by means of which the whole series

of signals could be hastened or delayed without alteration of the interval. The interval itself could be altered at pleasure while the apparatus was in operation. Though the design was illustrated primarily as a mechanical device which might find many applications, it was pointed out that it was immediately applicable to Mr. Langley's method of preventing personal equation in transit observations.

Mr. W. J. Spillman, of the U. S. Department of Agriculture, read a paper on 'The Theory of Combinations Applied to Mendel's Law.' He first stated briefly the law, which expresses the probable character of hybrids and their progeny, and the theory which Mendel and others had proposed to explain the facts in the case, illustrating the theory for monohybrids and dihybrids, and giving general formulæ he had deduced for finding the number of types that may be expected in the progeny of any hybrid, and the relative proportion of each type in any generation of any hybrid. He then showed what departures from the law may be caused by chance distribution of parent characters in the progeny. Taking the hypothetical case in which each hybrid produces ten ovules, he showed that "the chance that five shall possess a character of one parent and five the corresponding opposite character of the other parent is 25 per cent. In other words, when there are ten ovules on each plant, in 25 per cent. of the cases we may expect to find the pair of characters distributed amongst the ovules exactly as called for by theory. In .1 per cent. of the cases all the ovules will possess the character of one parent, and all will possess the character of the other in a like number of cases. If each plant has 100 ovules, the pair of parent characters will be equally distributed in only 8 per cent. of the cases." The chance than any particular distribution of a pair of characters amongst the ovules shall occur was shown to be

$$\frac{n!}{2^n r!\,(n-r)!},$$

where $n=$ the number of ovules per plant, and $r=$ the number of ovules on any plant that possesses the same parent character. He also gave a formula to show the chance that the pollen which shall fertilize these ovules shall be such as to give any particular combination of the possible types in the progeny. Lantern illustrations showed the results obtained by crossing varieties of wheat, and graphically some of the results of mathematical analysis.

Mr. Marcus Baker then discussed the question 'Can the Equations

$$\begin{Bmatrix} x^2+y=a \\ x+y^2=b \end{Bmatrix}$$

be Solved by Quadratics?' He pointed out some relations of this problem to the theory of equations, showed that the general method of solving equations of the second and third degrees consists in reducing their degree or in transforming them to some typical form which is solvable, and gave the criteria by which the few solvable types of equations of the fourth degree may be recognized. According to these criteria the given equations cannot be solved by direct methods.

At the 556th meeting of the Society, held October 25, Professor S. W. Stratton, director of the National Bureau of Standards, spoke on 'The Present Status of the Metric System in the United States and Great Britain,' detailing the various attempts to obtain permissive legislation, and some of the numerous associations and societies that had forwarded memorials to Congress.

Professor E. B. Rosa, also of the bureau, then by invitation, with the aid of lantern views, described the 'Plans for the Buildings of the National Bureau of Standards.' One building is to contain all the machinery, while another is to be as free as possible from jar; every modern convenience is to be provided in the various rooms, the temperatures of which will be regulated by thermostats controlling the supply of dust-free warm or cooled air.

Charles K. Wead,
Secretary.

NEW YORK ACADEMY OF SCIENCES, SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

At the meeting of October 6, 1902, the program of the evening was made up of informal

reports of the members upon work done during the summer in matters of interest to the section.

George F. Kunz exhibited a section of the tusk of the elephant Tip that was killed several years ago because he had become so cross. The section of the tooth showed a large cavity amounting to a couple of cubic inches, near the end of the conical cavity at the root of the tooth. It was suggested that possibly this cavity represented an ulceration of the tooth and that the bad humor of the elephant was really due to a bad tooth. After discussion by Professor Cattell and others, it was apparently the opinion of those best qualified to know that this cavity was not the result of any such ulceration, and that probably the elephant would not suffer from toothache in any case.

William Hallock made an informal report upon barometric and boiling-point observations made during the ascent of Mt. Whitney during the month of August. He called attention to the use of the boiling-point apparatus as checking the barometer, and to the necessity of taking into consideration the temperature and humidity of the air, as well as the simple barometric pressure. He also referred to certain interesting lava fields on Whitney Creek to the southwest from Mt. Whitney.

G. B. Pegram gave an interesting account of the work done at the magnetic observatories in this country, and especially at the one at Cheltenham, Md., with which he was connected during the summer vacation.

Dr. D. S. Martin referred to the interesting minerals exhibited at the exposition of the South at Charleston, and showed a sample of the ash from Mt. Pelée which was brought to Charleston on one of the incoming vessels. He will report more in detail upon this subject in the section of mineralogy later on.

S. A. MITCHELL,
Secretary of Section.

TORREY BOTANICAL CLUB.

AT the meeting of the Club on October 29 the first paper presented was by Miss F. A. Mulford, 'Remarks on *Gerardia decemloba*, Greene,' with exhibition of specimens. The plant was found at Hempstead, Long Island, September 5, 1902. This is the second station for the species, it having first been found by Professor Greene at Washington, D. C., in 1898. Dr. Britton followed with remarks upon the peculiar physiography of the Hempstead plain, its isolation, and the lack of trees, which is perhaps due to fires.

The second paper was by Miss Anna Murray Vail, on 'Some Rare Books Recently Added to the Library of the New York Botanical Garden.' This will shortly appear in the *Journal of the Botanical Garden*. Among some 400 works of the older botany recently procured by the Garden and now exhibited to the Club, the oldest is a fifteenth century Gothic manuscript of Macer Floridus' 'De virtutibus herbarum.' The oldest printed volume is one of the 'Ortus Sanitatis,' from the end of the fifteenth century; the next, the Venice edition of 1509 of the 'Aggregator practicus,' one of the herbals often known simply as 'Herbarius.' Later notable works secured include many of those of Mattioli, Dodoens and Lobel; the rare first volumes issued by Dodoens (his 'De frugum,' 1552) and by Clusius (1557); also a copy of Clusius' greatest work, his 'Rariorum' of 1601, of special interest because a presentation copy from Clusius himself. Rarities include a Passaeus of 1614, and the elephant folio of the 'Hortus Eystettensis' of 1613, in unusually fine preservation. There is a fine copy of Rivinus of 1690; and one of Linnæus' rarest works, his autobiographical pamphlet of 1741, 'Orbis eruditi,' believed to exist in only four copies.

The third paper was by Dr. Rydberg, 'A Review of a Recent Monograph of *Campanula rotundifolia* and its Allies.' Discussing this paper, Dr. MacDougal called attention to the work of Goebel on this plant. He said that Goebel had been able to produce rounded leaves on *Campanula* by experiment, and in any part other than the inflorescence, but that it had not been possible to prevent the formation of the rounded basal leaves.

The final paper was given by Dr. Arthur Hollick, on 'Buried Swamp Deposits of Maryland.'

Along the shores of the Chesapeake Bay swamp deposits of the Pleistocene era are being uncovered by water action. These occur under from five to thirty feet of gravels. Among the vegetable remains discovered, there were described and shown stumps of the bald cypress, cones of two species of *Pinus* (*P. echinata* and *P. Strobus*), with beech and hickory nuts. Many seeds are now being determined by experts of the Department of Agriculture. When the determination of the seeds is completed a good account of the ancient flora of that region can be given.

A comparison of the living with the fossil plants of the locality shows that, except for the bald cypress, the plants now growing seem the same as those there in geologic times.

In discussing the conditions attendant on the formation of the ancient flora and its disappearance, Dr. Hollick stated that the land had undergone elevation twice and subsidence twice. The first elevation preceded the formation of the flora which was to be found mainly in the valleys. The area was then depressed and completely submerged, and at length was covered by sand brought in by the waves. After the first elevation and during the first subsidence deposits were formed either *in situ* or at the mouths of the valleys; these, after the second elevation, are now being exposed by erosion. At the present time also a third subsidence is taking place, during which a second series of vegetable deposits are being laid down. The rate of this subsidence has been calculated to be about two feet in the century.

EDWARD S. BURGESS,
Secretary.

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

November 7.—The following papers were reviewed: Frank Springer, 'Unitacrinus, its Structure and Relations,' by Dr. Austin F. Rogers. M. E. Haug, 'Review of Theories of Glaciation,' from *Revue generale des Sciences,* by Dr. A. A. Julien.

H. W. SHIMER,
Secretary.

TORONTO ASTRONOMICAL SOCIETY.

OCTOBER meeting, President R. F. Stupart, F.R.S.C., Director of the Observatory, in the chair.

Mr. A. F. Miller stated that on three nights he had succeeded in observing the spectrum of comet 'Perrine' (b. 1902); he had seen three bright bands, and occasionally a fourth very faint band. The bright band in the green seemed to correspond to the green band of the Bunsen flame. The bands were sharp towards the red end of the spectrum, indicating the light to be emitted by a hydrocarbon gas. The nucleus gave a continuous spectrum and appeared to consist of several small bright masses involved in the coma. The paper for the evening was entitled 'The Application of Lord Kelvin's Theory of the Ether to the Stellar Universe.' The theories that had led up to the vortex theory were reviewed and an outline of Kelvin's views regarding vortices in a continuous fluid were presented with demonstrations. It was pointed out that the trend of thought amongst observational astronomers just now was to regard the universe as limited rather than infinite in extent. If the continuous ether be limited the envelope would be extremely elastic. A runaway star dashing against the interior surface would rebound without loss of energy. Such a surface would represent a stone wall between the cosmos and blank space beyond. The vortex theory had found favor with physicists because it possessed the virtue of simplicity and offers facilities for explaining certain peculiarities of behavior of matter and ether not otherwise readily explained as elasticity, energy of motion, method of conservation and dissipation (or degradation) of energy and possibly inertia and gravitation as well. The fact that the energy of motion is always as the square of the velocity was cited as evidence that whatever the ultimate nature of energy may be it cannot be *motion per se;* if energy be motion and motion only it could not require fourfold motion to double the motion (velocity) either of matter or ether. The existence of an ether of some sort was undeniable, but theories of its ultimate structure were advanced provisionally as instru-

ments of research to lay hold of the facts and arrange them in something like rational order.

J. R. COLLINS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A QUESTION IN TERMINOLOGY.

IN replying to Professor Campbell's earnest request to explain a problem in terminology,* I feel as though an apology were necessary for taking space in SCIENCE to state one of the elementary principles of terminology adopted by recent writers on the botanical system. Had Professor Campbell evidenced as much familiarity with the development of the botanical system as followed in continental Europe and America, as with the stereotyped text-book classifications of non-systematic botanists, he would not have credited me with any new proposition in my criticism of his text-book, or have spoken of the system I have attempted to follow as in any sense '*his* system.' The criticism offered was purely a matter of usage or form, and has nothing whatever to do with our conceptions of how this or that group shall be divided, or whether orders or any other categories of classification are all of equal value—another equally elementary problem that would seem to require no answer here.

Modern classification does not commence with the universe and divide it into kingdoms and subkingdoms on the old plan of monarchical and special creation. This has passed from the horizon like Rafinesque's attempts to reduce the forms of thunder and lightning to genera and species. In accordance with prevailing evolutionary conceptions, modern classification does commence with the individual and attempts to show its relationship to other created things. In this view a species is a group of related individuals, and a genus is a group of related species. As we reach the higher category, *tribe*, we have reserved a special termination for the sake of convenience and uniformity, deriving the tribal name from a characteristic genus of the tribe adding the termination EÆ. In a similar way the family is characterized by the termination ACEÆ likewise added to a generic name. This time-honored family termination in plant classification was long abused and muddled by the English school by speaking of families as 'natural orders' of plants, and this practice lingers still among some of the old school in America. So far the recent usage of systematic botany practically coincides with that long in use; in order, however, to coordinate botanical classification more nearly with that long followed in zoology, and to distinguish properly the order from the family, Lindley's termination for the 'alliance' (*cohors* of Bentham and Hooker), -ALES, has been adopted to distinguish the next higher category above the family. A group of related families is, therefore, properly an order and is distinguished by the termination -ALES. This modern system proposed at Berlin, but not always consistently followed even there, calls for rigid adherence to the use of these terminations each for its special category in classification and for that alone. The terminations then indicate the rank of the group—a perfectly rational and eminently practical system. This was a minor part of my original criticism to which Professor Campbell has taken exception. He changed a name which had been duly proposed as a *class*—*i. e.*, a group of related orders which in this case (*Anthocerotes*) happens to contain a single order and a single family—and used the form '*Class Anthocerotales*.'

To apply the modern system to the pteridophytes, I should say that, from the starting point of the typical ferns (Family Polypodiaceæ), the related families (Cyathe-

* SCIENCE, II. **16**. 705, 31 O. 1902. Had my original criticism (*Torreya*, **2**: 108–111) of Professor Campbell's irregularities in terminology extended to the ferns, I could have mentioned various other inconsistencies; *e. g.*, *Order* Ophiogloss*aceæ*, *Order* Filices, *Order* Lycopodi*neæ*, *Class* Equiset*ales*, etc. The ferns are placed in *Class Filicales* at one point (p. 246) and as *Filicineæ* at another (p. 265), where they are grouped into orders. We also have the '*Order* Isoet*aceæ*' (p. 266) marshaled with other eusporangiates under the Class Filicales, and again appearing as 'The *Isoetineæ*,' 'a distinct *order*,' next to the 'Ord. III. Selaginellineæ' of the Class Lycopodiales. (The *italics* of course are mine.)

aceæ, Schizæaceæ, Ceratopteridaceæ, etc.) form with it a related group which we denominate *Order Filicales*. If Professor Campbell wishes to make a class to include the order Filicales and other related orders, no one could have the slightest objection, but in accordance with the recognized principles of modern systematic botany Professor Campbell is not at liberty to name his classes with the termination *-ales* for that is reserved for orders and for orders alone.

The usage of 'Our Native Ferns' (sixth edition), to which reference is made, is strictly in accord with the above in the two cases quoted from the systematic portion of the work. On page 63 where the term *Order Equisetaceæ* is used, there is clearly an error, resulting from an oversight in correcting the electros, which at that point have escaped revision since their first printing in an earlier edition when *order* was still used as a synonym of *family*.

The orders of pteridophytes which we would recognize at the present time are: (1) Ophioglossales, (2) Marattiales, (3) Filicales, (4) Salviniales, (5) Equisetales, (6) Lycopodiales, (7) Isoetales. I believe this disposition of the last group, which contains a single genus, is much more logical than the plan followed by Professor Campbell in his 'University Text-book' of leaving these humble aquatics dangling between two classes with no secure resting place whatever. They have certainly become differentiated from other pteridophytes to this extent, as Professor Campbell himself clearly states.

L. M. UNDERWOOD.

COLUMBIA UNIVERSITY,
November 4, 1902.

A POINT IN NOMENCLATURE.

REFERRING to Professor Cockerell's note in SCIENCE, November 7, permit me to say:

Under the name of *Monacanthus oblongus*, Schlegel included two species, one large in size (since called *modestus*), the other small and more strikingly formed (since called *broekii*). I have retained Schlegel's name for the smaller species, because his figure represents it, his description is chiefly based on it and his references to the larger species are casual and comparative. The larger species Schlegel regarded as '*Individus adultes*' in which the specific characters of caudal filaments and dorsal serrations had been lost. As Schlegel's 'type specimen,' in the modern sense, was clearly one of the smaller species, I retain his name of *oblongus* for it, although he regarded the larger species (*modestus*) as the adult of the same species. Wherever possible, the question of type of genus or species should be decided on data in the original work, without reference to subsequent literature.

DAVID STARR JORDAN.

NEW YORK ARCHEOLOGY.

TO THE EDITOR OF SCIENCE: Dr. Merrill, of the New York State Museum, suggests that a brief account of archeological collections of interest be added to the bulletins now being issued, as a convenience for students of our local antiquities. This might be inserted in one of the bulletins yet to appear, or, if the amount of material warrants it, form a subject by itself. I know fairly well the more important collections, but there are many which have escaped my personal attention, and some inconspicuous ones contain valuable articles. With a view to carrying out this plan I would be glad to receive notes of any and all collections, public or private, which serve to illustrate the aboriginal history of New York. Photographs of articles or cases will be of great assistance, and correspondents may well give brief accounts of any local collections known to them.

I can not definitely say what the published results will be, for these will depend on the importance of the matter sent in. Ample reports are very desirable and will be placed on permanent record, but may necessarily be much reduced for publication. The idea is to make such a report as will enable students easily to find what they want in the way of illustration and information. At the same time an idea may be gathered of the abundance and character of local relics. For preliminary use the number of specimens may be given, character, material, locality, with fuller accounts of special forms. The intelli-

gent collector will scarcely need directions on those points.

Of course all this is intended to illustrate New York archeology, but this has relations to other parts of the land, and some cabinets contain fine and valuable specimens from other states. These are not to be overlooked, and I have several such cabinets in my mind. They are interesting in themselves and valuable for comparison.

This communication will not directly reach all those whose aid is desired, but if others will call attention to it good results may be expected. I am often surprised at finding some article of special interest in some hitherto unknown collection. Hence the importance of reaching every student of this great subject. May I hope for a speedy and general response from those interested.

W. M. BEAUCHAMP.

204 MAPLE ST., SYRACUSE, N. Y.
October 22, 1902.

PRICKLES OF THE PRICKLY ASH.

IT might be well to call attention to an error occurring in Bailey's 'Elementary Textbook of Botany,' 1901, p. 105, figure 157, where it states that the 'prickles' of the prickly ash are modified stipules. Seeing that the same error occurs in Bailey's 'Encyclopedia of Horticulture,' it may be supposed that it is not a mere typographical error.

In the case of the prickly ash, *Xanthoxylum americanum*, Mill., the prickles are true prickles, having no connection with the internal structures, as they would have if they were stipular in nature. These prickles occur frequently at the bases of the leaves, giving rise very probably to the false notion as to their morphology. However, they do not occur at the bases of all the leaves, there being not infrequently no signs of them. Furthermore, they are occasionally found elsewhere, on the branch, and also on the rachis of the compound leaf.

In Chapman's 'Flora of Southern United States,' 1897, it states, under family characters, 'exstipulate leaves,' and, under *Xanthoxylum*, 'trees or shrubs, commonly armed with stipular prickles.'

Gray states, as a character of the order, 'stipules none,' and, under *Xanthoxylum*, 'stems and often leaf stalks prickly.' Gray is correct, but Chapman, with many others, is in error. The structures referred to are not stipular, but are true prickles. Stipules are not found in any of the genera of the family to which *Xanthoxylum* belongs.

J. B. DANDENO.

THE NEXT ERUPTION OF PELÉE.

IN the Boston *Transcript* of September 3, 1902, the writer called attention to the peculiar sequence of eruptions in Martinique, as follows:

Date.	Preceding Interval.	Violence.
May 5.		Destruction Guerin Factory.
May 8.	3 days.	Destruction St. Pierre.
May 20.	12 days.	Further destruction St. Pierre and destructive wave at Carbet.
June 6.	17 days.	More incandescent material.
July 9.	33 days.	Larger stones at Morne Rouge; more incandescent material: detonations heard at Barbados.
Aug. 30.	52 days.	Destruction of Morne Rouge: great wave; many lives lost.

It will be seen that the interval is increasing and each time the culminating explosion of steam and hot waters has been somewhat more violent, though until recently there have been no good records kept. At present Lacroix is recording the phenomena from day to day. There were minor eruptions other than those above recorded, notably on May 26, three times in June, and after August 21; but those tabulated may be described as eruptions of first magnitude.

Exploration of the craters has shown that they contain boiling water during periods of calm, and the eruptions begin with the ejection of this water; steam follows, charged with débris. An eruption of this kind is comparable to a geyser. If such comparison is permissible, the sequence may indicate for each great eruption a release of strain and an increased cavity system, allowing infiltration of larger volumes of water, and requiring a

longer period in consequence before explosive conditions are again reached.

With the kind assistance of Professor L. S. Marks, the writer has attempted to determine the next date when Pelée is likely to erupt violently. Lacroix's latest observations, of November 4, indicate that the volcano is still intensely active, and this suggests that the *final* culmination did not come in August, as was the case with Krakatoa. An examination of the intervals and their differences shows that no simple arithmetical law will serve for the progression shown. A graphical solution may be obtained by platting a curve for the known intervals and extending this curve to cover the next interval. Professor Marks used this method; the extension of a smooth curve through the dates from May 8 to August 30 inclusive indicates that the next interval is about 112 days, if the same law holds. There is no simple analytical solution of the curve.

This would give December 20 or thereabouts as the date of the next great eruption of Mont Pelée. A French astronomer has predicted an eruption December 16,* because at that time the moon will be full, and when over Martinique will be at that point in her orbit nearest to the earth, and hence the lunar pull will be at a maximum with reference to any possible local instability in the earth's outer rock-film. It has been suggested that earlier eruptions were in singular coincidence with moon phases.

So far as prediction is possible, therefore, on the basis of such insufficient data, two lines of reasoning suggest mid-December as a time when a great eruption of Mont Pelée is likely to occur. T. A. JAGGAR, JR.

HARVARD UNIVERSITY,
November 18, 1902.

* *L'Opinion*, Fort de France, Martinique, October 21, 1902.

SHORTER ARTICLES.

THE ETHNOLOGICAL SIGNIFICANCE OF ESOTERIC DOCTRINES.

IN recent years the study of the esoteric teachings found in American tribal society has become one of the favorite subjects of research of ethnologists. The symbolic significance of complex rites, and the philosophic views of nature which they reveal, have come to us as a surprise, suggesting a higher development of Indian culture than is ordinarly assumed. The study of these doctrines conveys the impression that the reasoning of the Indian is profound, his emotions deep, his ethical ideals of a high quality.

It seems worth while to consider briefly the conditions under which these esoteric doctrines may have developed. Two theories regarding their origin suggest themselves: the esoteric doctrine may have originated among a select social group, and the exoteric doctrine may represent that part of it that leaked out and became known, or was made known, to the rest of the community; but it may also be that the esoteric doctrine developed among a select social group from the current beliefs of the tribe.

It seems to my mind that the second theory is the more plausible one, principally for the reason that the contents of the teachings among different tribes are often alike, no matter how much the systems may differ. Almost all the rituals that are the outward expression of esoteric doctrines appear to be old, and many have probably existed, almost in their present form, for considerable periods. Nevertheless, there is ample evidence of frequent borrowing and changes of sacred rites. Examples are the Sun Dance, various forms of the Ghost Dance, and the Mescal ceremonials. Miss Fletcher has called attention to the fact that Pawnee rituals have influenced the development of the rites of many tribes of the Plains. I might add similar examples from the Pacific coast, such as the transmission of Kwakiutl rituals to neighboring tribes.

There is also abundant proof showing that the mythologies of all tribes, notwithstanding the sacredness of some of the myths, contain many elements that can be proved to be of foreign origin. It seems very likely that similar conditions prevailed in the past, because the wide distribution of many cultural features can be understood only as the effect of a long-continued process of borrowing and dissemination.

Since the esoteric teaching refers to the

rituals, and is often largely based on mythological conceptions, it seems plausible that it should have developed as a more or less conscious attempt at systematizing the heterogeneous mass of beliefs and practices current in the tribe. Whenever a certain ceremonial came to be placed in charge of a small social group, were they chiefs, priests or simply men of influence, the conditions must have been favorable for the development of an esoteric doctrine. The thoughts of the men charged with the keeping of sacred rites must have dwelt on philosophical or religious questions, and it would seem natural that in the succession of generations the sacredness of the rite grew, and its philosophic significance increased in depth.

If this view is correct, the esoteric doctrine must have been evolved on the foundation of the general culture of the tribe, and must be considered as a secondary phenomenon the character of which depends upon the exoteric doctrine.

The opposite view, that the exoteric doctrine is a degenerate form of esoteric teaching, does not seem to me equally plausible, because it presupposes a highly complex system of actions and opinions originating spontaneously in a selected group of individuals. It is difficult to conceive how, in tribal society, conditions could have prevailed that would make such a development possible. This theory would seem to presuppose the occurrence of a general decay of culture. There is no reason that compels us to assume that such a decay has taken place, although it may have occurred in exceptional cases. If, on the other hand, we assume that the esoteric doctrine developed from popular beliefs, we do not need to assume any cultural conditions materially different from those found at the present time. It is quite evident that the esoteric doctrine, after it was once established, influenced, in its turn, popular belief, and that, therefore, there is a mutual and probably inextricable interrelation between the two doctrines.

If these considerations are correct, then the esoteric doctrine must, to a great extent, be considered as the product of individual thought. It expresses the reaction of the best minds in the community upon the general cultural environment. It is their attempt to systematize the knowledge that underlies the culture of the community. In other words, this doctrine must be treated like any other system of philosophy, and its study has the same aims as the study of the history of philosophy.

Two characteristics of esoteric doctrine are quite striking. The first is that at the bottom of each doctrine there seems to be a certain line of thought which is applied to the whole domain of knowledge, and which gives the whole doctrine its essential character. This line of thought depends upon the general character of the culture of the tribe, but nevertheless has a high degree of individuality in each tribe. The theory of the universe seems to be based on its schematic application. The second characteristic is that, notwithstanding this systematization of knowledge, there remain many ideas that are not coordinated with the general system, and that may be quite out of accord with it. In such cases the contradiction between the general scheme and special ideas often escapes entirely the notice of the native philosophers. This phenomenon is quite analogous to the well-known characteristics of philosophic systems which bear the stamp of the thought of their time. The philosopher does not analyze each and every conclusion, but unconsciously adopts much of the current thought of his environment ready-made.

The theories regarding the origin of esoteric doctrine may be proved or disproved by a careful study of its relations to popular beliefs and to esoteric doctrines found among neighboring tribes. It is evident that the material needed for the solution of the problem includes both the esoteric teaching and the popular forms of belief.

What has been said before shows that, to the ethnologist, the problem of the genesis of exotery is of no less importance than that of esotery. However we may consider the origin of the latter, it must be admitted that it is the expression of thought of the exceptional mind. It is not the expression of thought

of the masses. Ethnology, however, does not deal with the exceptional man; it deals with the masses, and with the characteristic forms of their thoughts. The extremes of the forms of thought of the most highly developed and of the lowest mind in the community are of interest only as special varieties, and in so far as they influence the further development of the thought of the people. It may, therefore, be said that the exoteric doctrine is the more general ethnic phenomenon, the investigation of which is a necessary foundation for the study of the problems of esoteric teaching.

It is, therefore, evident that we must not, in our study of Indian life, seek for the highest form of thought only, which is held by the priest, the chief, the leader. Interesting and attractive as this field of research may be, it is supplementary only to the study of the thoughts, emotional life, and ethical standards of the common people, whose interests center in other fields of thought and of whom the select class forms only a special type.

It has taken many years for the study of the culture of civilized peoples to broaden out so as to take in not only the activities of the great, but also the homely life of the masses. The appreciation of the fact that the actions of each individual have their roots in the society in which he lives, has developed only recently, and has led to the intensive study of folk-lore and folk-customs that is characteristic of our times. It seems peculiar that, with increasing knowledge of the more complex forms of Indian culture, we seem to be losing interest in the popular belief; that we look for the true inward significance of customs among the select few, and become inclined to consider as superficial the study of the simpler and cruder ideas and ideals of the common folk. If it is true that for a full understanding of civilized society the knowledge of the popular mind is a necessity, it is doubly true in more primitive forms of society, where the isolation of social groups is very slight, and where each and every individual is connected by a thousand ties with the majority of the members of the tribe to which he belongs.

Far be it from me to deprecate the importance of studies of the philosophies developed by the Indian mind. Only let us not lose sight of their intimate relation to the popular beliefs, of the necessity of studying the two in connection with each other, and of the error that we should commit if we should consider the esoteric doctrine, and the whole system of thought and of ethical ideals which it represents, as the only true form of the inner life of the Indian.

Franz Boas.

THE ROYAL SOCIETY'S CATALOGUE OF SCIENTIFIC PAPERS.

The following memorandum has been issued by the treasurer of the Royal Society:

The Royal Society has been engaged continuously during the past forty years in cataloguing the various scientific papers which have been issued in all parts of the world since the beginning of the last century. The original scheme of the 'Catalogue of Scientific Papers' provided that the papers should be catalogued only under the names of their respective authors, arranged alphabetically. This 'Authors' Catalogue' has now been carried down to the end of 1883, and comprises twelve quarto volumes.

More recently it has been decided to prepare also a subject index of the same papers —that is to say, a catalogue in which the papers are indexed according to the subject-matter of which they treat. Considerable progress has been made with this subject index, though nothing has as yet been published.

The expense of this work has been very large, since, although a great amount of gratuitous labor has been readily given by fellows of the society, it has been necessary to employ a considerable permanent salaried staff upon the preparation of the copy for the press. At first the printing and publication were undertaken by H.M. Stationery Office, the treasury having determined that the catalogue should be printed at the public expense. In coming to this conclusion the Lords of the Treasury stated that they had regard 'to the importance of the work with reference to the promotion of scientific knowledge generally,

to the high authority of the source from whence it came, and to the labor gratuitously given by members of the Royal Society for its production.' This arrangement, however, came to an end after the publication of the first eight volumes. The treasury in 1889 informed the society that the catalogue could no longer be printed and published by the Stationery Office. The unsold volumes were, however, handed over to the society, and Parliament voted a sum of £1,000 to assist the society in continuing the printing and publication. The four subsequent volumes have been printed and published by the Cambridge University Press, which has received subsidies from the society for this purpose, and receives the sums arising from sales.

The total sum expended by the society upon the catalogue down to the end of June last has been £14,790 5s. 5d. Towards this expenditure a donation of £2,000 was made by Dr. Ludwig Mond in 1892. Sums amounting to £524 11s. 9d. have been received as the proceeds of sales of the volumes handed over to the Royal Society by the Stationery Office, and, as already stated, £1,000 has been received from the treasury. The council has also hitherto devoted the income of the Handley fund (which they have power to apply as they may deem best for the advancement of science) towards defraying the cost of producing the catalogue. The total sum received from this source has been £2,394 11s. 10d. A sum of £341 11s., arising from money invested until actually required, has also been available for the same purpose. These pecuniary aids amount in all to £6,260 14s. 7d. As will be seen, they have not been nearly sufficient to meet the whole cost, and the society has been compelled to make up the balance of £8,529 10s. 10d. out of its own general income.

As it became obvious that to permanently continue to prepare and publish catalogues of the ever-increasing stream of scientific literature was wholly beyond the means of the society, the council took steps to obtain international cooperation in this great work. Such cooperation has happily been secured, and the cataloguing of the scientific literature of the present century is now in the hands of an international council. The Royal Society has, however, incurred large special responsibilities in connection with the matter, having undertaken, *inter alia,* to act as the publishers of the catalogue, and also to advance the capital required to start the enterprise.

The International Catalogue is concerned only with the scientific literature appearing after the commencement of the present century. The Royal Society's Catalogue, as already stated, is at present carried down to the end of the year 1883 only, and the subject index for that period is but partially dealt with. The foreign delegates, assembled to consider the establishment of the International Council, expressed their sense of the great importance of the Royal Society's Catalogue, and of the obligations which men of science in all countries were under to the society for having undertaken it. They also expressed the hope that the society would complete the catalogue up to the close of the last century, so as to bring it into line with the International Catalogue. Indeed, it may be said that the International Council is proceeding on the assumption that this will be done.

In order to complete the catalogue, it will be necessary to prepare and publish a catalogue of authors for the seventeen years 1883–1900, and to complete and publish the subject index for the whole of the past century. The council of the Royal Society are satisfied that this work must be done, and have not felt justified in refusing to undertake it. They have accordingly commenced operations, and it is hoped that the copy may be produced ready for the press in about five years. Owing to the enormous increase in the number of scientific publications at the close of the last century, it is estimated that to complete the catalogue, and to subsidize a publisher for undertaking the printing and publication, he retaining the proceeds of the sale, will cost at least £12,000.

The question now arises whether the funds of the Royal Society ought to continue to be burdened with any part of this expense. The activity and responsibilities of the society

have greatly increased in recent years, and it is much straitened by its inability to increase its expenditure, either on its own establishment, or in other directions, owing to the incessant demands of the catalogue. The council consider that the time has now come for them to appeal to those who are in a position to afford substantial financial assistance, to enable them to complete this great undertaking without devoting any part of their funds, so sorely needed for other purposes, to this object. They are thankful to be able to announce that Dr. Ludwig Mond, F.R.S., has been so impressed with the importance of the catalogue, with the necessity for producing the subject index of the scientific literature of the past century so far as possible in the same complete form as that adopted by the International Council for the literature of the present century, and with the justice of the view that the Royal Society ought for the future to be relieved of the cost of producing the catalogue, that he has most generously added to his previous gift of £2,000 the munificent donation of £6,000, payable in four annual instalments of £1,500.

The president and council have also much pleasure in stating that Mr. Andrew Carnegie, fully appreciating the value of the society's undertaking and the claims that it has on the liberality of those who, though not fellows of the society, are interested in the promotion of natural knowledge, has contributed the handsome sum of £1,000 towards its accomplishment. They venture to hope that others may be willing to contribute towards a fund to provide for the total cost of this national work.

SCIENTIFIC NOTES AND NEWS.

The Royal Society has this year awarded medals, as follows: The Copley medal to Lord Lister in recognition of his physiological and pathological researches in regard to their influence on the modern practice of surgery. The Rumford medal to the Hon. Charles Algernon Parsons for his success in the application of the steam turbine to industrial purposes and for its recent extension to navigation. A Royal medal to Professor Horace Lamb for his investigations in mathematical physics. A Royal medal to Professor Edward Albert Schäfer for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain. The Davy medal to Professor Svante August Arrhenius for the application of the theory of dissociation to the explanation of chemical change. The Darwin medal to Mr. Francis Galton for his numerous contributions to the exact study of heredity and variation contained in 'Hereditary Genius,' 'Natural Inheritance,' and other writings. The Buchanan medal to Dr. Sydney A. Monckton Copeman for his experimental investigations into the bacteriology and comparative pathology of vaccination. The Hughes medal to Professor Joseph John Thomson for his numerous contributions to electric science, especially in reference to the phenomena of electric discharge in gases.

At the meeting of the National Academy of Sciences, held in Baltimore November 11 and 12, a grant of eight hundred dollars was made from the income of the J. Lawrence Smith bequest to Dr. O. C. Farrington, of the Field Columbian Museum, Chicago, to enable him to conduct certain investigations upon the meteoric bodies of America.

The daily papers state that Major Ronald Ross, of the Liverpool School of Tropical Medicine, will receive the award of a Nobel prize.

Nature gives the following list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1903 at the anniversary meeting on December 1. The names of new members are printed in italics: President, Sir William Huggins, K.C.B., O.M.; treasurer, Mr. A. B. Kempe; secretaries, Sir Michael Foster, K.C.B., and Dr. Joseph Larmor; foreign secretary, Dr. T. E. Thorpe, C.B.; other members of the council, Mr. W. Bateson, Dr. W. T. Blanford, *Professor H. L. Callendar, Mr. F. Darwin, Professor H. B. Dixon,* Professor G. Carey Foster, Right Hon. Sir John E. Gorst, *Professor J. W. Judd,*

C.B., Right Hon. Lord Lister, O.M., Professor G. D. Liveing, Professor A. E. H. Love, Professor H. A. Miers, *Professor E. A. Schäfer, Captain T. H. Tizard, R.N., C.B.,* Professor H. H. Turner, *Sir J. Wolfe Barry, K.C.B.*

MR. ALBERT F. WOODS, chief of the Division of Vegetable Physiology and Pathology of the U. S. Department of Agriculture, has gone to Nebraska to visit the experimental stations and gather information in regard to the beet-sugar industry.

DR. A. D. HOPKINS, of the Division of Entomology, U. S. Department of Agriculture, has returned from an extended trip to Arizona, southern California, northern Idaho, the Puget Sound country and the Black Hills, where he made investigations of the damage done timber by insect pests.

THE jubilee of the eminent anatomist, Golgi, who is now in his eigthy-sixth year, was celebrated at Pavia on October 28. He was presented with an edition of his works in three volumes.

MR. J. C. HAWKSHAW gave the presidential address before the British Institution of Civil Engineers on November 4. Afterwards medals and premiums were awarded as follows: The Howard quinquennial prize to Mr. Robert A. Hadfield, for his scientific work in investigating methods of treatment of alloys of steel, and on account of the importance in industry of some of the new products introduced by him. A Telford gold medal to Mr. William M. Mordey and a George Stephenson gold medal to Mr. Bernard M. Jenkin, for their joint paper on 'Electrical traction on railways'; a Watt gold medal to Mr. J. A. F. Aspinall, for his paper on 'Train resistance'; a Telford gold medal to Mr. John M. Gray, for his paper on 'The variable and absolute specific heat of water'; a George Stephenson gold medal to Mr. Richard Price-Williams, for his paper on 'The maintenance and renewals of waterworks'; a Watt gold medal to Dr. William B. Dawson, for his paper on 'Tide-gauges in northern climates and isolated situations.' The Miller scholarship, tenable for three years, and the James Forrest medal were presented to Mr. Herbert F. Lloyd, for his paper on 'The design, manufacture and erection of wrought steel conduits for gravitation and pressure water supply.'

THE list of birthday honors in Great Britain includes the names of Mr. W. H. Power, F.R.S., principal medical officer to the Local Government Board, who has been made a companion of the Order of the Bath; Sir J. J. Trevor Lawrence, a Knight Commander of the Royal Victorian Order; and Mr. H. J. Chaney, superintendent of the Standards Department, Board of Trade, Companion of the Imperial Service Order.

DR. H. P. JOHNSON, having undertaken the investigation of icterohæmaturia of sheep, is at present in Helena, Montana, and requests that all correspondence, exchanges, etc., be sent to that address.

MR. G. M. RITCHEY, of the Yerkes Observatory, gave an illustrated lecture on 'Recent Celestial Photography,' under the auspices of the Smithsonian Institution, November 22, in the lecture hall of the U. S. National Museum.

MAJOR WALTER REED, an officer of the Surgeon-General's Department of the Army, and well known for his researches on the relation of the mosquito to yellow fever, died at Washington on November 23, at the age of fifty-one years.

MR. FREDERICK JAMES CARNELL, laboratory assistant in physics in the Sheffield Scientific School, of Yale University, died on November 16 from an accidental shot while hunting.

THE death is also announced of Mr. William Henry Barlow, F.R.S., a well known British civil engineer, on November 12, at the age of ninety years.

THERE will be an examination to fill the position of piece-work computer in the Nautical Almanac Office on December 9 and 10, and to fill a similar position in the Naval Observatory on January 6 and 7.

ACCORDING to *La Semaine Médicale* Dr. Steiner, a Dutch physician, has discovered a method of anæsthesia among the Javanese produced by compression of the carotid artery. From a story collected by Dr. J. R. Swanton,

of the Bureau of Ethnology, when working in the interests of the Jesup North Pacific Expedition, it would appear that the phenomenon involved was known to Indians of our northwest coast.

FORMAL notification has been received by the Lewiston Land Office from Commissioner Hermann of the General Land Office, of the temporary withdrawal of 2,300,000 acres in Idaho and Boisé Counties, lying south of the present Bitter Root forest reserve, pending an investigation as to the advisability of adding the territory to the reserve. With this addition, the Bitter Root Reserve will comprise 5,300,000 acres, or an area as large as the State of Massachusetts. The land now temporarily withdrawn lies along the Salmon River watershed, and includes Thunder Mountain, Marshall Lake, Warrens and other mining districts.

THE sixth meeting of the Congress of American Physicians and Surgeons will be held in Washington, on May 12, 13 and 14, 1903. The subjects chosen for special discussion are 'the pancreas and pancreatic diseases' and 'the medical and surgical aspects of diseases of the gall-bladder and bile ducts.' The president, Dr. W. W. Keen, of Philadelphia, has chosen as the subject of his address 'The duties and responsibilities of trustees of medical institutions.'

ON the 14th inst. the chemists of Syracuse organized themselves into a society with the following officers:

President, J. D. Pennock, Solvay Process Co.

Vice-President, Professor E. N. Pattee, Syracuse University.

Secretary, Professor H. Monmouth Smith, Syracuse University.

Treasurer, Dr. J. W. Mathews, Crucible Steel Co. of America.

Councilors, Dr. H. G. Carrell, Solvay Process Co.; Matthew Adgate, General Chemical Co.; Edw. L. French, Crucible Steel Co. of America.

The society begins with a membership of 35. Meetings will be held monthly, except during the summer.

THE New England intercollegiate geological excursion, announced a few weeks ago, took place on Saturday, November 1, an exceptionally beautiful autumnal day, when teachers and students to the number of sixty-nine from nine colleges and a number of normal and secondary schools, met at Holyoke, Mass., and were led by Professor B. K. Emerson, of Amherst, to some of the most interesting localities in the district, in connection with the Triassic sandstones and lava flows. A superb view of the Connecticut valley was obtained in the afternoon from the top of Mt. Tom, the summit of which was gained by a funicular railroad. It is planned that the third excursion of the series, a year hence, shall be to the Hanging Hills, near Meriden, Conn., under the leadership of Professor Gregory, of Yale.

A SERIES of investigations is about to be begun by the Division of Hydrography of the U. S. Geological Survey, under M. O. Leighton, resident hydrographer, into the effects of coal-mine refuse upon the rivers of the coal region. It has been commonly observed that the streams running close to the anthracite mines of eastern Pennsylvania and other mining localities are heavily charged with sulphur, and that their waters often have a slightly acid reaction; the beds of the streams are also often overlain by heavy deposits of sulphur precipitated from the water. It is the purpose of the investigations to discover the effects, deleterious or otherwise, upon the rivers which receive the polluted streams. One of the immediate results of the pollution is the driving away of all varieties of fish, which were once abundant in these streams, but a more important consideration is the influence of the sulphur-charged streams on the processes of decomposition of organic matter going on in rivers into which they flow. The mine refuse, especially such as comes from culm-pile washery, is a troublesome source of pollution. The separation of the coal from the waste is accomplished through the use of quantities of water, which are returned to the streams laden with fine coal-dust. For some distance below the outlets of these washeries the streams have the appearance of liquid stove-polish, and the coal-dust, extending for many miles downstream, is gradually deposited, in places even filling the

channels of the streams. Such water is unfit for household or even for manufacturing uses, and though the coal refuse is not an organic pollution, nor a chemical poison, its presence in large quantities is a troublesome factor to be considered when water filtration is projected. The distances downstream to which this material persists under different flow conditions will also furnish an interesting subject for study.

PROFESSOR T. C. CHAMBERLIN, of the University of Chicago, has had charge, during the present season, of the investigations carried on by the U. S. Geological Survey in the deposits of Pleistocene age in the United States. An important part of these deposits consists of the gravel and till widely spread over the northern tier of states by the invasion of the great glacier during a late geological epoch. These gravels are of considerable economic importance on account of the clays found in connection with them in certain localities. In the middle states they are of importance on account of the water retained by them, which is available for wells; while in the western states they are associated with auriferous metals. Professor Chamberlin has been assisted by Professor Salisbury and Mr. W. W. Atwood in the Rocky Mountain region, by Frank Leverett and W. F. Taylor in Michigan and by W. C. Alden in Wisconsin.

THROUGH the influence of Director Stewart, of the Experiment Station at West Virginia University, and with the cooperation of some prominent citizens of Morgantown, the U. S. Division of Good Roads in the Department of Agriculture has been induced to supervise the building of three miles of good road in Monongalia county. Work upon this piece of model road is now going on. It extends from the west end of the suspension bridge at Morgantown down the river three miles, to Randall. A portion of it is to be built of Telford blocks, and the remainder is to be a MacAdam road. Citizens furnish the material and labor and the U. S. government furnishes the machinery and supervises the work.

THE Department of State has received from the Belgian legation, Washington, under date of November 3, 1902, notice of the International Congress of Hygiene and Demography, to be held at Brussels from September 2 to September 8, 1903. An invitation is extended to the United States to be officially represented, and the wish is expressed, in behalf of the Minister of Foreign Affairs, that committees of propaganda, composed of persons eminent in medical science and hygiene, be organized in the different states, with whom the central committee at Brussels may correspond. The questions to be discussed will include bacteriology, microbiology, parasitology applied to hygiene; alimentary hygiene, applications of chemical and veterinary science, sterilization, use of antiseptics; sanitary technology; industrial and professional hygiene; hygienic transportation, best means of disinfection; administrative hygiene, aim and organization of medical inspection, quarantine regulations, and supervision of tenement houses; colonial hygiene, malaria, beri-beri, etc.; demography. Blank applications and copies of regulations and programs, sent by the legation, are filed for reference in the Bureau of Foreign Commerce.

UNIVERSITY AND EDUCATIONAL NEWS.

THE twenty-fifth anniversary of the opening of the State University of Colorado, in Boulder, was appropriately celebrated on November 13, 14 and 15. The general address was given by President Jacob Gould Schurman, of Cornell University, who spoke on 'Problems of Modern University Education as Suggested by the Charter of the University of Colorado.' The other addresses were given before the professional schools. Dr. Frederic S. Lee, of Columbia University, spoke on 'The Scientific Aspect of Modern Medicine'; Mr. Frederick N. Judson, of St. Louis, Mo., spoke on 'The Quarter-Century in American Jurisprudence'; and Professor Dugald P. Jackson, of the University of Wisconsin, on 'The Potency of Engineering Schools and their Imperfections.' The University was established on paper as early as 1861 in the early territorial days of

Colorado, but it was not until 1874 that the Legislature of the Territory made the first appropriation for its support. When Colorado was admitted to the union in 1876 the constitution provided that the university should become an institution of the state. Since that time the university has been well supported both by a regular portion of the tax levy and by special appropriations which have been made from time to time. The present year's enrollment is about 550 in the University while the State Preparatory school, managed also by the Regents, has 375 pupils. Last June 71 degrees were conferred.

THE new building of the Central High School of Philadelphia, erected at a cost of $1,500,000, was dedicated on November 22. President Roosevelt and several members of his cabinet were present. The exercises, which were continued on the twenty-fourth and twenty-fifth, included addresses by Dr. W. T. Harris, commissioner of education, Dr. Thomas M. Drown, president of Lehigh University, and R. E. Thompson, president of the school.

THE Supreme Court has handed down an opinion sustaining the decision of Justice Truax in directing the New York University to reconvey to the Medical College Laboratory of the city of New York the premises which were deeded over to the university in 1897 in accordance with a plan for combining the laboratory and the university.

WE learn from *The British Medical Journal* that the Gordon Memorial College, at Khartoum, which Lord Kitchener opened on November 8, is now ready for the chemical and bacteriological research laboratories presented by Mr. Henry S. Wellcome during his recent visit to the Soudan. The fixtures and appliances made in England have already been shipped. The equipment for scientific work is said to be complete in every detail, and to be equal to any similar laboratories in Europe. The Sirdar has appointed Andrew Balfour, M.D., B.Sc., D.P.H., of Edinburgh, director of these research laboratories. The Soudan affords excellent opportunities for the study of tropical diseases, especially malaria, typhoid, and dysentery, and it is hoped that the results of the investigations of Dr. Balfour and his staff will be of the greatest importance. Dr. Balfour will also assist the authorities in the investigation of the criminal poisoning cases which are very frequent in the Soudan. The nature of some of the poisons used by the natives is at present obscure, and it is possible that the work in these laboratories may considerably increase our knowledge of toxic agents. Apart from the original researches and general sanitary work, Dr. Balfour and his staff will devote their attention to the study of the cereals, textile fibers, and various matters affecting the development of the agricultural and mineral resources of the Soudan.

DR. HERMAN KNAPP has resigned the chair of ophthalmology at the College of Physicians and Surgeons, Columbia University, and has been appointed emeritus professor.

PROFESSOR R. OGDEN DOREMUS has retired from the chair of chemistry in the New York City College, with which he has been connected for fifty-one years.

W. H. BOUGHTON, assistant professor of civil engineering in Denison University, has accepted the position of professor of civil engineering in the University of West Virginia.

DR. C. H. GORDON, superintendent of the city schools of Lincoln, Nebraska, has been appointed instructor in geology and geography in the University of Nebraska. Dr. Gordon retains his position at the head of the city schools and will, for the present, give a course in petrology and during the spring semester a course in geography, the latter designed especially for teachers or those having teaching in view. In addition to this work he will also, during the spring semester, repeat his course of lectures on school supervision and management given last year.

IT is announced that Dr. Martin H. Fischern, associate in physiology at the University of Chicago, and Dr. Charles D. Rogers, assistant in physiology, will go with Professor Jacques Loeb to the University of California.

Erratum: In the review of Professor Baldwin's 'Development and Evolution,' page 820 above, for *othoplasy* read *orthoplasy*.